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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE RELATION OF MATHEMATICS TO ENGINEERING.

A FEW years ago technical education as we now understand it was unknown in America. We have now in our midst more than 20,000 students preparing themselves distinctively for the engineering profession.

While the technical schools of the country have had a development which for rapidity, strength and importance is little short of marvelous, yet their rise and growth have been profoundly influencing the thought as well as the welfare of the nation. Especially in the domain of mathematics have they had a directing and vivifying influence which is little short of a revolution. Today mathematics wishes no stronger reason for her existence and no stronger call to her cultivation than the fact that she is the unchallenged doorkeeper to the appreciation and mastery of the physical sciences, both in their theory and in their application by the engineer to things useful.

The time is past when mathematics is referred to by the thinkers of the day as being principally a discipline. It is of course true that, rightly pursued, mathematics is a discipline, but it is far more, it is a knowledge, a tool, a power, a civilizer. The day is gone when, on the one hand, the student, Chinese fashion, learns his geometry word for word from cover to cover or memorizes all the propositions of his

* Vice-presidential address before Section D, American Association for the Advancement of Science. St. Louis meeting, December, 1903.

analytic geometry down to the last index and subscript, or, on the other hand, when the devotee of a cult toasts his favorite subject with the words 'Here's to the higher mathematics, may they never be useful.'

To the workaday world the higher ranges of mathematics have been a sealed book; the man who traverses them successfully a magician—a man whose mental occupations awaken mingled feelings of awe and pity, awe that he can soar so high, pity that he wastes his strength in such useless flight. A generation ago the mathematician was joined in hand with the Roman and the Greek, and the three easily persuaded the educational world that they were the divine trio. Without them for a basis there could be nothing but a sham college course. Why it was that these three lines of study held such a commanding and, for the most part, unchallenged position, it is now difficult for us to say. Possibly they gained higher esteem as means of mental discipline because their most ardent votaries so seldom succeeded in making them directly useful except in certain narrow professional lines. Of the men in college courses who studied required mathematics beyond trigonometry very few gained any vital conception of analytic geometry and the calculus. To most collegians the mass of symbols with which they juggled in pursuing these subjects was a distressing nightmare, a matter of jest and to be forgotten with all possible speed.

Our colleges to-day have seen a great light and have reformed their curricula. They now know there is no discipline in the pursuit of mathematics to the man who does not understand its language. Early in his course, if not throughout it, the student is allowed the more rational way of getting his education, by pursuing subjects that he *can* understand. This sensible treatment of educational material has grown up during the development of technical colleges and may be referred in a measure at least to their influence. Certainly great advance in the teaching of mathematics has recently been made, yet very much remains to be done, and the next great forward movement seems to be coming directly from the engineers and the forces they are setting in operation.

The literature on the question of reform in the teaching of mathematics is growing rapidly. In 1901 John Perry, professor of mechanics and mathematics of the Royal College of Science, London, and chairman of the Board of Examiners of the Board of Education in Engineering and Mathematics, produced a profound impression upon the British Association by a paper on 'The Teaching of Mathematics.' His ideas require attention further along. In Germany Nernst and Schoenflies, for example, have met the thought of the hour in their 'Einführing in die Mathematische Behandlung der Naturwissenchaften.' In our own country Perry centers are springing up for the reformation and profound improvement, if not revolution, of mathematical teaching in our secondary schools. In the west the apostle of this movement is Professor E. H. Moore, of Chicago University. One needs only to read his admirable presidential address before the American Mathematical Society in New York almost exactly a year ago to understand the full meaning and extent of the changes sought.

The address will be found in the number of the *Bulletin of the American Mathematical Society* for last May, and it will repay a careful perusal on the part of those of you who have not read it. Professor Moore has been counted as a pure mathematician of the most pronounced type, but into this new movement he has thrown himself with the ardor of one whose whole life had been spent in applying a wide range of mathematical power to the design and construction of the great objects of engineer-

ing. If the reformation which has been planned and begun shall go on to completion, the mathematical teaching in the secondary schools of the middle west will have little resemblance ten years hence to the work of to-day.

Arithmetic, algebra, geometry and trigonometry will no longer be set off in 'water-tight compartments,' but will all be demanded in various combinations for the solution of single elementary problems. Squared and polar coordinate paper will represent the facts to the eye in geometrical symbolism and at the same time will give a practical introduction to the fundamental ideas of analytics and the calculus. By pursuing through the four years of secondary school life a carefully selected and properly graded problem course the pupil will review the whole range of elementary mathematical truth and become familiar with it, not only in theory, but also in practice. He will never be asking, 'what use?' But with the enthusiasm which original investigation only can arouse he will find his educational material in the simpler problems of the shop, the store, the farm, the bank, the railroad, the steam-boat, the steam-engine, the electric motor, political economy, geodesy, astronomy, time, space, force and so on through the range of the elementary aspects of the things of daily thought and experience in this complex and highly developed life of ours. Such a change can not be perfected in a day. No inferior or untrained teacher can succeed with it. Elementary work must be in the hands of those who have come into living contact with some of the deep, broad problems of chemistry, of physics and of engineering, demanding for their solution a large acquaintance with the higher ranges of mathematics. In turn colleges and universities which strive to train such teachers must revise their mathematical courses and adjust themselves to these new ideas.

In many of our leading institutions exactly that thing is occurring, stimulated perhaps in the first place by the great demand of technical colleges for mathematicians in sympathy with engineering ideas.

Those who are dealing with freshmen in colleges are asking the question, 'What is the matter with our preparatory schools?' If you wish to see this question strongly formulated and illustrated, read the commencement address of 1903 by President Ira Remsen at Mount Holyoke College.

This is the indictment of the schools, that they use, largely to the exclusion of the thought element, a mass of formal and conventional educational material and thus paralyze thought and make abortive any natural mental growth.

In the grades the clear, keen, accurate thinking of childhood soon disappears and does not usually show itself again until the laboratory or the practical problems of life make it once more dominant. We refer to President Remsen's question only so far as it relates to mathematical training. The technical schools long ago recognized the barren results of primary and secondary mathematical instruction and have been deeply interested in its improvement. Most keenly this loss has come to the engineer who must subject himself to the long, hard discipline necessary in his profession for the successful solution of his original and independent problems. Yet certain people seem to look askance upon the engineer and discover no advancement of science in the design of an entirely new machine to carry out an entirely novel idea. According to their notion, Whitney was not a scientist when he invented the cotton gin, nor Fulton when he constructed the first steam-boat, nor Morse when he perfected the telegraph.

This was all pure commercialism. Even if these worthies cared nothing for the financial side of their work and only sought to serve and benefit their fellow men, they

could not be classified with the man who describes an unrecorded bug, or the one who makes a new but useless chemical compound. The latter work without the hope of direct money return for their labors. Therefore, theirs is the true method and the higher life even when their disinterested consecration to science is mingled with a hope that a little fame will bring them an increase in salary from some practical person or persons who appreciate their unselfish efforts.

However all of this may be, we know that the essence of any engineering work worthy the name is its independence. With this there is usually some degree of originality, as it seldom happens that the same problem repeats itself in every particular. What is more, with the independence and originality of the engineer must come character—confidence in his own mental processes and a willingness to shoulder responsibility in embodying his conclusions. A scientist may announce his discovery of the tidal evolution of the moon and yet be forgiven if later it should be shown that he is in error. Not so with the engineer. When his bridge falls under prescribed conditions of safe load, his own ruin as well as that of his structure is complete. Of all men living the intellectual life the engineer is the one most interested in sound and logical training for his profession and most intolerant of all shams. It is not surprising then that the one subject in secondary schools whose natural purpose is to train the student to severe logical and productive thinking should respond most fully to his influence. Neither is it surprising that from the ranks of the engineers should come the reformer who sees clearly the defects of our present mathematical work in the lower grades and who is moving powerfully to secure better conditions.

We may sum up what now seem to be the best ideals in secondary mathematics as follows:

These ideals come from the engineering professions.

They insist upon quality rather than quantity.

They insist that the problems shall be largely concrete and shall be worked out to an accurate numerical result.

They insist that the thought shall precede the form, that the symbol shall not conceal the thing symbolized.

They insist that systematic and progressive problems based upon every-day experience and observation shall be, to a much greater extent, the materials of education.

They demand that the several elementary mathematical subjects from arithmetic to the calculus shall develop side by side in the boy's mind.

They demand that the mastery of these subjects shall be more the work of the judgment than of the memory.

They demand that from first to last, at least during the secondary period, mathematical ability and the ability to think clearly, investigate closely and conclude correctly shall develop together, and to the extent that four well-spent years will on the average permit.

Those who formulate these ideas contend that they lead to the correct mathematical training for all professions and all careers.

It remains for us to consider the mathematical courses in our technical colleges. What is their relation to the development of the engineer? What shall they include? How shall they be administered? These are not new questions, neither has the last word been said in answer to them. Fifteen years spent in directing engineering mathematics gives the writer some excuse to undertake some further discussion of them.

Important contributions were made by Professor Mansfield Merriman in 1894, and Professor Henry T. Eddy in 1897, whose

articles are published in the *Proceedings of the Society for the Promotion of Engineering Education*, Volumes II. and V. But among the most suggestive discussions during the last year, as well as all previous years, are the papers of some of our brightest electrical engineers presented at the joint meeting last July at Niagara Falls of the society just mentioned and of the American Institute of Electrical Engineers and published this year in the proceedings of both societies. To those interested in finding the best educational conditions leading to the average as well as the most important engineering operations of the day these papers come with peculiar weight and authority. Judging from the expressions of opinion contained in them the active engineer in his occupation, at least, cares nothing for the philosophic basis of the concept of number, nor for the geometry of non-euclidian space, nor for Grassman's *stufe* of the fifth or sixth degree, nor for computations of plane triangles when the sum of the angles is less than 180 degrees. These subjects may and should interest the professional mathematician, but the engineer asks first for the ability to use numbers rapidly and to carry numerical computations, no matter how complex, to an accurate conclusion. As for ordinary mathematics, including of course elementary geometry, algebra and trigonometry, the engineer should know them as he 'knows the currency of his native country. In other words, he ought to be able to make change with ease, quickness and accuracy —not as if one were in a foreign country in a constant state of painful reckoning.'

On a basis of barter modern business would be strangled. The very existence of commerce in the modern sense, in which the line of cost and profit is so finely drawn, would be utterly impossible without a standard currency. So without mathematics engineering would be a mass of empiricism and tradition. Instead of a pioneer leading the way in the progress of the people it would be an outcast trailing in the rear of every science.

This proposition that mathematics is the very bone and sinew of an engineering course needs no discussion. It is everywhere conceded. The extent and nature of the mathematical element in the curriculum, however, are two decided fluents with curves of opposite slope. More mathematics but fewer kinds seems to be the tendency. The opinion appears to be gaining ground that the purely descriptive and highly specialized and professionalized elements in our technical courses should be reduced, while more subjects with a mathematical basis, with long unbroken continuity and bound together with a strong logical element should command the attention of the student to the end of his undergraduate period.

Upon the question what mathematical subjects shall the undergraduate courses include in our technical colleges, opinions are decidedly at variance. Upon the four ordinary elementary subjects the sentiment is practically unanimous, but these should be principally taught in the secondary schools. The practical people, however, are inclined to relegate analytic geometry and the calculus to the scrap pile.

To such subjects as vectors, theory of functions, theory of groups, they allow no place whatever.

One can not but feel that this verdict against analytic geometry and the elementary calculus—not to mention higher subjects—is a great pity. Especially does it seem true when we recall that instruction in these two lines forms the principal mathematical element of the second and third years of the ordinary technical course and that the calculus itself is probably the most powerful and wonderful tool for in-

vestigation that the genius of man has ever contrived.

The student of mathematics who has reflected deeply upon the meaning and interpretation of its symbolic language knows that man, in his struggle for the mastery and direction of nature's laws and processes, has no more subtle and no more powerful ally than he finds in the calculus. The other subjects leading to it are conventional and highly artificial, but with this one we return to simplicity and operate with perfect ease and freedom in the realms of time, space and force.

As we find nature operating by growth, and force by insensible gradations, so over against that the calculus is the science of continuous number. Why then does the mathematician find so much in this, his favorite subject, while the practical engineer—even the one of great ability, proficiency and success—is inclined to think that time spent upon it is wasted or at least not employed to the best advantage? Why this great divergency in conviction?

No one will doubt the ability of our best mathematical instructors and teachers, nor their perfect familiarity with the matter they are teaching. But are analytics and the calculus—especially the latter—presented to the average student in the best way? Does not the formal smother the thought element and leave nothing but routine machine work upon symbols? As the student learns laboriously how to find the first derivative of a wide range of *rider* problems has he a faint conception even of what it is all about? Sir William Thomson, you know, said he did not understand an equation until he could make a model of it. Is the average student able to make a model of his operations with the differential calculus? And when he takes up the integral calculus and begins his attack upon a mass of algebraic and transcendental functions, using at times devices of great complexity and extreme refinement, does he usually walk by sight or by faith? Does he not often go forward long and painful journeys in utter darkness as to the meaning of it all, trusting, hoping, praying that by and by his teacher and his text-book will land him on solid ground and in the clear light to revel and operate in a new world of thought and action? How many men of good natural endowments, who are sorely needed in the higher ranks of the world's workers, become terrified in this period of distressing gloom; how many have lost individual initiative and independence and are content thenceforward to walk, not upright, vigorous, aggressive, daring, in the clear light of right reason, but by faith, humble and submissive?

Why do practical men almost unanimously place calculus among the dispensable elements of a technical curriculum?

The answer, of course, is very simple; they have never found any use for it, probably because they have never learned how to use it. Yet they dare not pronounce against it altogether. They know that Rankine and Maxwell were master mathematicians, and that through this mastery of the most powerful of tools they were able to do for terrestrial what Newton and Laplace did for celestial mechanics. In college the engineer has not learned to use the modern tool called the higher analysis; it remains to him as foreign currency. Out of college he has not time to learn its use. Are you a teacher of mathematics and did you pursue the subject under the direction of a master; yet how many classes did you yourself guide through the calculus before its hidden meaning, its range, its versatility, its power, were in any adequate measure revealed to you? How simple and how majestic it has now become! But if you were so slow in reaching the true light, is it to be wondered at that students

who go over the subject but once and under conditions not greatly superior to those of your own college days should not see clearly and should not use what they so little understand! Because, as matters now stand, the man who does not repeat his course in calculus many times will fail to appreciate it and use it, shall we say that it should be cut out of the engineering courses and its place taken by more algebra, more trigonometry and more descriptive geometry, or shall we retain it and reform its presentation? The true mathematical teacher will always vote for the latter proposition whatever may be the attitude of the professional man on the faculty or the pressure from the outside of the practicing engineer. How, then, may the higher analysis in our technical schools be made effective as a true means of discipline and as a tool with which to equip the engineer in his life of investigation?

It is to be understood that the answer to this question here is not claimed to be *the word* nor the *last word* on so important a topic. It is *a word* to be taken for what it is worth.

1. The most effective teaching of the higher analysis will be possible only when the reforms in mathematical instruction referred to earlier in this paper have permeated the principal secondary schools.

2. The teacher should be saturated with his subject. Not only should he be strong and apt on the formal side, but more important still, its inner meaning should be clear to him and its close relation to the phenomena of the objective and subjective life. Some contend that the only man to whom the mathematics of a technical college can be entrusted is an engineer. Does that make any difference? Rather are not these the essential questions? Does the man know his subject? In his teaching can he assemble from engineering and other records the material that will vitalize his work? Is he in sympathy with engineering essentials and ideals?

3. Throughout the college course the teaching should be mainly concrete. The problem, say from the physical sciences including engineering, should first be presented concretely. It should then be stated in mathematical symbols. The operations performed upon the symbols should be accompanied by drawings or models, the final result reduced to numerical form and then interpreted in language. Upon every problem the student must bring to bear the whole range of his acquired powers and be taught to select the shortest method within his ability.

In other words, all typical problems should receive a threefold consideration: (*a*) Its statement in words, and the statement in words of its solution when effected; (*b*) its graphical statement and solution involving geometry and mechanical drawing with squared paper; (*c*) its analytic statement and solution, ending with a numerical result.

4. The purely formal should be presented as a necessity arising from the so-called practical and in order that a body of knowledge and technical ability may be accumulated which will give the student easy control over the practical in whatever one of its various forms experience shows that it may arise.

5. The problems chosen should be progressive in character and their mastery should amount to a complete laboratory course in all that part of the higher analysis in which it is desirable that the engineering student should be well versed.

6. The course should be lecture and seminarium and individual, more after the manner of the German Technische Hochschule. The text-book should become a book of reference. The instructor should know clearly and be able to state accurately the limitations of his methods; but abstruse

discussions of obscure points should be postponed as long as a due regard for logical development will allow. Time is wasted in removing difficulties whose existence and importance the student has not yet recognized.

These are some of the necessary extensions into college work of the reformation now urged upon the secondary schools, and though every one of them seems familiar enough when taken separately; all together their united application to the mathematical courses in our technical colleges amounts to a departure from our present traditional methods little short of revolutionary. Yet isn't this the thing our engineers are demanding, and isn't this the logical way to train an engineer in higher mathematics? Isn't it the way to approach the higher mathematics anywhere or in any kind of a school?

The pure mathematician may object and exclaim, What is to become of our curricula which have been evolved after so many years of intellectual conflict! The rule is so much algebra, so much geometry, so much trigonometry, so much analytical geometry and so much calculus. At the end the student has passed with greater or less success so many formal examinations upon so many formal topics and his acquirements are supposed to range somewhere between the maximum and minimum grade of passing. But are these the questions which the enlightened educator of today is asking? Is it not *How much power?* A dry, barren, fruitless familiarity with a number of highly specialized and unrelated things can not be education. The engineer demands that the unity of the mathematical branches should be emphasized and that they should accumulate in the soul of the student not as dry and unrelated facts, but as a magazine of energy.*

* Little has been said in this paper about descriptive geometry and mechanical drawing as necessary parts of a general mathematical training. Both of these subjects are of the highest value as disciplinary studies. They make definite and effective other mathematical material. Is not one reason for the barrenness of mathematics in university courses the fact that these branches simple though they are, have been so long neglected? Do we not find one important explanation of the effectiveness of technical college mathematics in the fact that these subjects are always a large part of a technical training?

You may ask for some definite concrete expression upon the way that the study of calculus should be undertaken. This paper will close with an attempt at a brief answer to this question.

We will suppose that experimentally or otherwise the student is familiar with the equation of falling bodies $s=\frac{1}{2}gt^2$. By this time also the student must be somewhat skilled in the use of squared paper and acquainted with this curve itself through its application to parabolic mirrors or otherwise. Perhaps, our parabola had been studied from its geometrical side as a conic section. It now takes on a symbolic meaning, for it gives in a certain sense a picture of the first law of falling bodies. But does the student grasp the full meaning of the picture? Using the approximation $g=32$, we have a numerical equation. The abscissas of the curve represent elapsed time; the corresponding ordinates represent total space traversed. At some point on the curve proceed geometrically and analytically to construct the tangent, at every step making a threefold interpretation, one of the curve, one of the analysis, and one of the fact connected with these in the familiar phenomena of a falling body. Show the limiting position of the secant, deduce the number towards which your successive numerical approximations tend, and connect both of these with the velocity of the body at the point considered. Draw the tangent and show

how it represents uniform velocity. Show that the results reached at one point on the curve are general and apply equally well to every point and that everywhere on your curve the geometrical tangent and your analytic limit interpret each other and give the rate or velocity of the falling body.

Note that the tangents are changing, that the corresponding numbers are changing and that these constitute a rate of change of velocities. Show graphically the oblique straight line representing the changing velocities. Give its graphical, its numerical and its nature interpretation. In the same way study the line parallel to the axis of abscissas representing gravity. Study the graphs and their relation to each other. Study the series of numbers resulting from the selection of equal increments along the X-axis, the relation, therefore, of these operations to the theory of number series. Connect the first differential coefficient with the tangents and with rates, the second with the changes of tangents or of rates of tangents, and thus with the thing in this problem that produces the changes of velocities, that is, with the force of gravity. Note the deformation of the original curve if the resistance of the air had been considered and its influence accounted for by some simple law. Construct the curve of the body projected upwards. Let up and down destroy each other, so that the ordinates at each point will be the algebraic sum of opposite motions. Note the point in the curve when the projected body is for an instant stationary in the air. Observe its connection with the first differential coefficient. Note the deformation of the curve due to the resistance of the air acting according to some assumed law.

Similarly, construct approximately the smooth integral curve which represents the movement of a steam railroad train from station to station fifty miles apart. Connect the contour of the curve with velocities and with forces, including in the latter the steam in the cylinder, gravity assisting or retarding, friction and air resistance always retarding. Note how the second differential coefficient carries us back to steam in the cylinders, the third to the causes leading to a variation of the artificial forces, such as fuel, skill in stoking, etc. Pursue maxima and minima problems in the same way. But now, instead of a rate of change directly dependent upon a conventional unit of time, we have relative rates of change and we quickly enlarge our ideas of the meaning and application of the first and second differential coefficient. We can safely begin the formal element of the subject. Even then we should continue the diagram and its interpretation, though we may be utterly unable to set the highly artificial equation over against any definite problem known to exist in nature.

Just as differentiation always has a symbolic interpretation in tangents and rates, so the integration of any expression may be interpreted as the finding of an area.

From engineering we have a remarkable series of connected quantities and these may be selected, as given by Professor W. K. Hatt in the *Railroad Gazette* of December 23, 1898, for illustrating the cumulative effect of successive integrations. Five successive diagrams used in engineering practice are connected by integrations. These are in their order the load diagram, the shear diagram, the moment diagram, the slope diagram and the deflection diagram.

But it is not necessary to enter further upon specific illustration. The higher analysis is replete with problems which the skilled teacher may use as stepping stones by which he may help the student to pass with safety to higher and higher mathematical attainment. Step by step he masters his method while he is gaining a

clearer insight into the causal relations of things about him.

The thought element is ever dominant. He goes from strength to strength until no task seems too difficult for his disciplined powers.

Two young men stand before an intricate machine. They are told that their success in life depends in large measure on their ability to understand and use it. One examines piece by piece the parts of which it is composed. He discovers the way in which these parts are connected, the material of which they are made, their size, their strength, their beauty. After long and arduous study, he knows very much about the machine but he can not put it in motion, he can not make it work, he can do nothing with it except to admire its perfection of form.

The other student begins to construct another machine like the one shown him. As it grows under his hands, he is constantly using it for every operation to which it can be applied. As it approaches completion he admires more and more its adaptability and wide range of useful applications. Its beauty no longer affects him greatly, but he is lost in wonder and admiration before its marvelous power. This power he harnesses to the car of progress and he himself becomes one of the benefactors of his race.

Do we need to stop long to discover who is the 'man thinking'?

In later years mathematical instruction in this country has greatly improved in its thought content, but it has responded slowly and conservatively to modern methods. We are still more English than German. In the work of training a master of the physical sciences the text-book and the senseless repetition of words and formulas falling upon the dull ear of an instructor half asleep have been replaced by the lecture, the laboratory and the seminarium. Why should not mathematics, so intimately related to them, follow their lead and partake in the benefits of modern methods carried to their legitimate and logical completion?

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THE AMERICAN PHYSICAL SOCIETY.

The winter meeting of the American Physical Society was held in cooperation with Section B of the American Association for the Advancement of Science at St. Louis, joint sessions being held on December 29–31, 1903. The business meeting of the Physical Society was held on December 30, and the program for that day consisted of Physical Society papers.

The meeting was a distinctly successful one. The program, consisting of twelve papers, was as large as could be satisfactorily handled, and contained several papers of exceptional interest. While comparatively few eastern members were present, the attendance was, nevertheless, well up to the average of previous 'annual' meetings. The large attendance of physicists from the middle west, most of whom are only rarely able to attend the meetings in New York, offered a strong argument in favor of more frequent meetings in that part of the country.

At the annual election the officers of the past year were reelected, *i. e.,*

President—A. G. Webster.
Vice-President—Elihu Thomson.
Secretary—Ernest Merritt.
Treasurer—William Hallock.
Members of the Council—Messrs. E. Rutherford and W. S. Franklin.

It was decided to hold the spring meeting of the society (1904) in Washington, this action being taken in consequence of a cordial invitation extended to the society by the Philosophical Society of that city. Not only is the local membership of the society in Washington large, but the ad-

vantages of the capital as a place of meeting are exceptional, as was evidenced by the very enjoyable meeting there last winter. It seems, therefore, that a successful meeting may be confidently expected.

The Physical Society also voted to accept an invitation from the International Electrical Congress to hold a meeting in St. Louis during September, 1904, in connection with the meetings of the congress.

It was the sense of the council that a definite plan should be presented by the council at this meeting looking to the establishment of a western section of the society.

The papers presented were as follows:

The Radioactivity of Ordinary Metals: E. F. BURTON.

The conducting power acquired by gases when confined in a closed metal vessel has been explained as the result of two causes: (1) The radioactivity of the metal walls; (2) a penetrating radiation from without, which reaches the confined gas by first passing through the walls of the vessel. Mr. Burton has attempted to eliminate the latter rays by surrounding the vessel with a screen of water. A decrease in the conducting power of the confined gas was in fact produced, the decrease being approximately proportional to the thickness of water, and amounting to 32 per cent. when the water was 60 cm. thick. While the vessel was surrounded by a water screen of this thickness its conducting power was tested for different pressures, ranging from 19 mm. to 752 mm. The conductivity was found to be almost exactly proportional to the pressure. The author concludes that the conductivity is due to a penetrating type of radiation.

Does the Radioactivity of Radium depend on the Concentration? E. RUTHERFORD.

The intensity of the γ-rays from radium bromide was determined by the electrical method, first when the salt was in the solid form, and second when dissolved in a solution of radium chloride. The volume occupied in the second test was more than a thousand times as great as that in the first. No difference in the intensity of the γ-rays could be detected. Since the intensity of these rays serves as a comparative measure of the activity, the conclusion is reached that the activity of radium is independent of the concentration in the range covered by these experiments.

The Heating Effect of the Radium Emanations: E. RUTHERFORD and H. T. BARNES.

The authors described the results of further experiments on this subject. (For the preliminary experiments see *Nature,* October 29, 1903.) The evolution of heat by the emanation and by the deemanated radium was followed from the time of separation throughout the radioactive life of the emanation. The variation of the heating effects with time was found to be the same as the variation in radioactivity, *as measured by the α-rays.* Estimating the volume of the emanation released by heating one gram of radium as between 6×10^{-4} c.c. and 6×10^{-5} c.c., and assuming its density to be about 100 times that of hydrogen, the authors compute that 1 gram of the emanation would radiate during its life an amount of energy lying between 2×10^{9} and 2×10^{16} gram calories. A pound of the emanation would radiate energy initially at the rate of about 100,000 horse power.

The Phosphorescence of Organic Substances at Low Temperatures: E. L. NICHOLS and E. MERRITT.

About 120 substances, chiefly organic compounds of definite composition, were tested for phosphorescence and fluorescence at the temperature of liquid air. Of these only 21 failed to show luminescence at this temperature, while in numerous instances

the phenomena were quite brilliant. Except the phosphorescent sulphides no substances were found whose phosphorescence was *diminished* by cold. Perhaps the most interesting substance tested was tetrachlorphthalic acid. This showed both phosphorescence and fluorescence at —186° C., while quite inactive at ordinary temperatures. It was also stimulated by Roentgen rays, fluorescing under their influence as brilliantly as a good X-ray screen.

The Spectro-photometric Study of Fluorescence: E. L. Nichols and E. Merritt.

The authors investigated the spectrum of the fluorescent light from fluorescein and other substances when excited by light of widely different wave-lengths. The spectrum was found to be the same in all cases, even when the wave-length of the exciting light was greater than that of the brightest region in the fluorescent spectrum. In agreement with Lommel, and in opposition to Lamansky, Becquerel and others, two conclusions are reached, viz., (1) the distribution in the fluorescent spectrum is independent of the exciting light; (2) for substances of this class Stokes's law does not apply.

The Electrical Conductivity of Liquid Films: L. J. Briggs and J. W. McLane.

The thickness of films of Plateau's solution was computed from the area and weight, and the resistance of the films was directly measured. It was found by this method that the specific conductivity of films about 1 μ thick is less than one third that of the solution in mass.

On the Use of Nickel in the Marconi Magnetic Detector: A. L. Foley.

A detector with a core of nickel wires was found to have about the same sensitiveness as one using iron. The greatest sensitiveness was obtained by using a core containing both nickel and iron wires.

On Double Refraction in Matter moving through the Ether: D. B. Brace.

Electric Double Refraction in Gases: D. B. Brace.

The author presented a brief preliminary account of work on the subjects mentioned in the two titles above, but looked upon the experiments as not yet carried far enough to make a detailed report desirable.

The Work of the National Bureau of Standards: E. B. Rosa.

The Spectrum of the Afterglow of the Spark Discharge in Nitrogen at Low Pressures: Percival Lewis.

The phosphorescence studied is produced only in the purest obtainable nitrogen. Instead of a continuous spectrum, which is observed in most cases of afterglow, the light in this case gave a banded or line spectrum. The spectrum contains a number of unidentified lines, of which four in the visible region are especially prominent. Certain of the lines of nitrogen, mercury and aluminium (the last due to the electrodes) were also present.

J. J. Thomson has advanced the hypothesis that afterglow effects are due either to chemical actions in a mixture or to polymeric changes in a pure gas. If this be the explanation—and it seems a reasonable one—how can a chemically neutral gas excite luminosity in every metallic vapor which may be present, such as mercury and aluminium?

The Spectrum of the Electrodeless Discharge in Nitrogen: Percival Lewis.

The discharge was obtained in the form of a ring by the use of an oscillatory discharge in a coil surrounding the tube. Any effects due to electrostatic influences were eliminated by screens of moistened pasteboard. The spectrum showed the bands of the second and third groups, as classified

by Deslandres in the case of the positive column of the ordinary discharge with electrodes. The first group was entirely absent. It was interesting to find that some of the characteristic bands of the negative glow were also observed.

ERNEST MERRITT,
Secretary.

SCIENTIFIC BOOKS.

A Monograph of the Culicidæ or Mosquitoes. By FRED. V. THEOBALD, M.A. Volume III. London, printed by order of the trustees of the British Museum. 1903. Pp. xvii + 359; 193 text figures; 17 plates.

Interest in matters connected with mosquitoes has been increasing so rapidly of late, and so many students and physicians in all parts of the world have been taking up the investigation of this family of dipterous insects, that Mr. Theobald's monograph of 1901, published in two volumes of text and one volume of plates, was hardly in the hands of investigators before almost enough material had accumulated for another volume. Between April, 1901, and February, 1903, over one hundred collections were received at the British Museum, and the present volume includes consideration of this material. In the volume are described 23 new genera, 88 new species and 8 new varieties. At this point Volume III. stops. Since that time already 25 new collections have been received at the British Museum, and whatever new forms are contained in these and subsequent collections will be described in journals, and it is not proposed to issue another volume until the arrival of new species slackens and the subject has reached a more final stage. This means that for some time to come people wishing to identify mosquitoes must base their work primarily upon the three volumes published and afterwards consult all sorts of scientific periodicals, both biological and medical, for descriptions of new forms, which will necessitate some rather extensive card-cataloguing. In the meantime it may parenthetically be stated that no doubt Mr. Theobald will be glad to name specimens for persons sending them to him, and the writer holds the services of his force at Washington at the disposal of inquiring medical men and other culicidologists.

In Volume III. the British Museum authorities have abandoned the colored plates which formed so attractive and excellent a feature of Volumes I. and II., but the text contains many figures giving anatomical details of the new species, including a number of figures of various stages. The plates are all done by the collotype process from photographs, and are in the main very good. Careful drawings would have been much better than some of them, especially the heads on Plate IX. and the larva and pupa on Plate XVI.

In the preparation of this volume Mr. Theobald has shown great care and very good judgment. He has been most industrious in bringing together many points concerning the biology of different species in spite of the fact that his main interest seems to have been in the classification of the adults, and as a matter of course the volume is a mine of information concerning the geographic distribution of species. He had before him practically no additional material from North America in the preparation of Volume III., although he introduces some Central American forms, some from the West Indies and a number from South America. The bulk of his additional material, however, has come to him from Africa, India and Australasian regions.

One point which he brings out which will be of interest to North American students is his decision that *Anopheles walkeri,* which he described from specimens (number not given) collected at Lake Simcoe, Ontario, in September by E. M. Walker, is really a synonym of *Anopheles bifurcatus* Linnæus of Europe, a species of rather wide European distribution, occurring from Lapland to Italy and the Mediterranean islands.

Since the publication of Volumes I. and II. an important attempt has been made by M. Neveu-Lemaire to formulate a classification of mosquitoes mainly on palpal and venational characters. Mr. Theobald shows that while the French author in his classification upholds certain genera proposed by Theobald

himself and which were originally based almost entirely upon scale structure, certain others of his genera suffer from the application of this class of characters. The main objection to the palpal characters is their difficulty to the student, and, if possible, for convenient use tables for the separation of species should be based upon characters which can be studied without mutilating the specimens. This plea Mr. Theobald makes for the retention of his scale characters, since they can be made out with any compound microscope, and even with a high-power hand lens. Mr. Theobald deserves great credit for the work which he has done with scale characters, but there can be no doubt that the rational classification depends to a greater extent for its generic characters upon such distinctions as have been pointed out by Neveu-Lemaire. It will be rather difficult to draw the line, for example, between the 'narrow curved scales' and the 'broad curved scales' found upon the heads of certain mosquitoes, since there are curved scales which it would be difficult to distinguish as narrow or broad. There is a gradation, in other words, which makes it difficult in some cases to accept them as generic characters.

Mr. Theobald has done a great and lasting service to the medical profession and to the students of biology in producing this elaborate monograph, and deserves the thanks of all classes. The authorities of the British Museum should also be included in this vote of thanks, since they have published the results of his labor in very beautiful form.

L. O. HOWARD.

International Catalogue of Scientific Literature. G, Mineralogy including Petrology and Crystallography. First Annual Issue. Published for the International Council by the Royal Society of London. Vol. XI., 1903 (January). Pp. xiii + 208.

The general character and scope of this international catalogue have already been sketched in this magazine (Vol. XVI., 1902, p. 861). This volume embracing mineralogy, petrology and crystallography is of the same high quality that has characterized the earlier appearing volumes on other subjects. The scheme of classification of the subject catalogue is as follows, the numbers given being the so-called registration numbers by which each section is designated: 0000 to 0070, general, including philosophy, history and biography, periodicals, text-books, addresses, institutions and nomenclature; 10 to 19, general mineralogy, including chemistry, mode of occurrence, economic mineralogy and artificial minerals, etc.; 30 to 32, determinative mineralogy; 40, new mineral names; 50, descriptive mineralogy with alphabetical list of mineral names; 60, geographical distribution; 70 to 73, meteorites; 80 to 87, petrology, including igneous, sedimentary and metamorphic rocks, unclassified rocks and chemical analysis of rocks; 100 to 750, crystallography, including geometrical and mathematical crystallography (105 to 150), crystal structure and growth (200 to 240), physical and optical crystallography (300 to 440), chemical crystallography (500 to 540) and determinative crystallography (600 to 750).

This scheme and a topographic classification of localities is printed in four languages. The catalogue proper is introduced by an authors' catalogue containing 1,072 entries, comprising 53 pages. The remaining 120 pages contain the subject catalogue as above outlined. The catalogue fills a want much felt by all workers in science, and while alterations in the scheme, especially in the subject classification, may suggest themselves later as advisable, there can be only praise for the work accomplished. The fact that larger funds and more complete equipment of the several bureaus will in the future make it possible to keep the catalogue more nearly concurrent with the period whose work it records insures a still greater usefulness for the work.

CHARLES PALACHE.

SCIENTIFIC JOURNALS AND ARTICLES.

The Popular Science Monthly for February has for frontispiece a portrait of Professor W. G. Farlow, president of the American Association for the Advancement of Science, while the first article is the address of the late president, Ira Remsen, on 'Scientific Investigation

and Progress.' This is followed by the address of David Starr Jordan, entitled 'Comrades in Zeal,' before the Sigma Xi Society. Edward S. Holden discusses 'The Predecessors of Copernicus,' giving much information about the early astronomers, and J. Madison Taylor considers 'The Conservation of Energy in those of Advancing Years.' Oliver C. Farrington treats of 'The Geographical Distribution of Meteorites' and Charles P. Pettus describes the origin and progress of 'Washington University,' whose fine and harmonious buildings will be a surprise to many. The final article is by G. A. Miller, on 'What is Group Theory?'

Bird-Lore for January-February opens with an illustrated article on 'The Black Tern at Home,' by Ernest Thompson Seton and Frank M. Chapman, and this is followed by 'Horned Larks in Colorado Springs,' by E. R. Warren. 'The Christmas Bird Census' comprises records by 78 observers scattered well over the country. There is a second paper, with colored plates, on 'The Migration of Warblers,' by W. W. Cooke, and an interesting prize essay in the department 'For Young Observers.' In the editorial section is a protest against 'humanizing the birds,' and under 'The Audubon Society' there is much of interest.

The Museums Journal of Great Britain for January has an article by Benjamin Ives Gilman, 'On the Distinctive Purpose of Museums of Art,' in which the writer takes the ground that there is a marked difference between museums of art and other museums. The function of the art museum is not primarily that of popular instruction, this being of secondary importance to its esthetic influence. The notices of art forgeries contained in the notes should put collectors of paintings and bric-à-brac on their guard.

PROFESSOR R. KRAUSE and Dr. M. Mosse, of Berlin, announce the foundation of a new *Centralblatt f. normale und pathologische Anatomie mit Einschluss der Mikrotechnik.*

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES. SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

THE regular meeting of the section was held on January 25 at the American Museum of Natural History in conjunction with the New York Branch of the American Psychological Association. Afternoon and evening sessions were held, the members dining together between sessions. The program was as follows:

Primary and Secondary Presentations: Dr. HENRY RUTGERS MARSHALL.

Dr. Marshall in his paper aimed to present evidence that presentations are always new presentations, and that, therefore, images can not be properly said to be copies of impressions, nor can what we call representations be properly said to be duplications of any presentations which have previously existed. His paper was a summary of an article which is presently to appear in *Mind.*

The Generic Relation of Organic Sensation and Simple Feeling: Professor MARGARET E. WASHBURN.

The Universe's Place in Man: Dr. FRANCIS BURKE BRANDT.

The paper emphasized the necessity for a fresh start in modern empirical investigation through a critical restatement of the postulates of experience. The starting point of every empirical science, it was contended, is individual conscious experience. The primary datum of individual experience is a perceptive and a conceptive consciousness combined organically in the unity of a personal life existent in a universe of persons. The material universe thus primarily takes its place in man rather than man his place in the material universe, for scientific philosophy has demonstrated beyond criticism, first, that the visible universe always exists primarily in and for a momentary perceptive consciousness limited in space, and second, that the unseen universe is always primarily a conceptive construction whose validity is always verifiable within the realm of momentary perceptive experience. The material universe, whether conceived

phenomenally or existentially, participates in one case in the content, in the other in the being of absolute personality, and as such, so far as individual man is concerned, is the objectification of the conditions of higher individual development.

Retinal Local Signs: Mr. Walter F. Dearborn.

This paper was offered as a critique of the first of the three Lotzean hypotheses concerning the nature of the retinal local signs. Experiments to determine the accuracy of the motor impulse, as shown by the ability to fixate directly eccentric visual stimuli forty degrees to the right of the primary line of regard, found an average error of corrective movements considerably in excess of the threshold value of local discrimination for the same part of the retina. These discrepancies between the accuracy of the motor impulse and the delicacy of local discrimination seem to necessitate some modification of the traditional view in regard to the nature of the local signs, or at least in regard to the relative importance of the motor factor.

Dewey's 'Studies in Logical Theory': Dr. Henry Davies.

In this paper only the four chapters contributed by Professor Dewey to the above work were considered.

Toward the right understanding of the work two conditions of a historical character must be borne in mind. One of these is the relation of recent logical theory to the Kantian dualism of sense and reason which tended to separate thought from its object. The other is the influence of the evolutionary method, which drives the investigator to study logical distinctions in the light of their genesis in experience.

Both of these conditions exert a profound influence over Dewey's thought. For it is the essence of his contribution to logical theory that he shows that the obstinate manner in which logicians have accepted the Kantian reading of experience is the most fruitful historical cause of the contradictions, *e. g.*, in Lotze's 'Logic' as well as in that of Bradley and Bosanquet. Dewey claims that this is a complete misreading of the thought situation.

On the other hand, common sense and empirical science with their pragmatic and evolutionary method disclose the real situation. Thought is a question of *specific* purposes, *specific* contexts and *specific* conflicts. Common sense and empirical science assume for these specific aims the unity and continuity of experience. The logical problem emerges when this is broken up by an inward conflict into fact and theory, datum and ideatum. The content of thought is just this conflict, which is only a temporary phase of the logical situation, the outcome of which must always be the reestablishment of the original unity in our experience.

It follows from this that logic can not contemplate as its aim a completely rationalized metaphysics. Rather its function is to act as a philosophy of experience, as a *method* by which experience may be advanced towards better and more complete knowledge. But the rectification of experience and the complete correlation of all the functions of experience presuppose a logic of genetic experience. It is Dewey's merit to have pointed this out and to have, in large part, supplied the need in the present work.

The Distribution of Errors in Spelling English Words: Professor Robert MacDougall.

Dr. MacDougall made a provisional report upon an investigation of the distribution of errors in spelling English words. These occur characteristically in the latter part of the word, but do not present a continuous increase from beginning to end. The curve of error is an anticlinal having its maximum in the third quarter of the word and its points of origin the initial and final letters, of which the latter is the higher in the scale of errors. Similar relations are presented by the component syllables, fewest errors occur in the initial, most in the median letters. Considered apart from their relation to the termination of the word, the frequency of error in successive letters is found to increase with each remove from the beginning of the word.

The Ultimate Relation between Magic and Religion: Dr. Irving King.

Magic and religion can not be legitimately

distinguished on the side of the actual content of their respective practices, nor by using such notions as that of the supernatural, unless they are critically reconstructed with reference to the type of culture in which they are applied. It seems more legitimate to differentiate magic and religion according to the types of situations within which they appear. Some tensions in the experience of the primitive man are merely occasional and appeal to him chiefly as an individual; others are more general and appeal more insistently to the consciousness of the social group. In connection with the former sort of tensions magical practices are developed, and in connection with the latter variety religion differentiates.

JAMES E. LOUGH,
Secretary.

BOTANICAL SOCIETY OF WASHINGTON.

THE seventeenth regular meeting of the Botanical Society of Washington was held at the Portner Hotel, January 7, 1904.

Messrs. A. D. Shamel, W. W. Tracy, Sr., Professor C. V. Piper and Professor W. M. Scott were elected to active membership.

At the close of the business meeting the following papers were presented:

The Identity of American Upland Cotton: MR. L. H. DEWEY.

The common cultivated cotton of the southern states is known in American botanical literature as *Gossypium herbaceum* L. European authors, especially in recent years, have referred it to *G. hirsutum* L. Nearly all authorities agree that the cotton of southern Asia, cultivated in India since the earliest records, also cultivated in southern Europe and known as the Levant cotton, is *G. herbaceum.* The descriptions of Linnæus do not characterize the species definitely, though 'five-lobed leaves' applies best to *G. herbaceum,* and 'acutely three- to five-lobed leaves' to *G. hirsutum,* but the authors cited by Linnæus state clearly that *G. hirsutum* is the American cotton.

The name *Gossypium herbaceum* has evidently been applied to American cotton as the result of a misidentification by early American authors and the assumption that it originated from seed brought from Europe. American upland cotton is almost certainly of American origin. Both American and Asiatic cottons exhibit a wide variation, but the general characters within the limits of variation are sufficiently constant to mark them with certainty as distinct species. *Gossypium herbaceum* has leaves with roundish or broadly acuminate lobes, yellow flowers purple at the base of the petals, toothed bracts and nearly spherical umbonate five-celled bolls to which the lint tenaciously clings. *Gossypium hirsutum* has acutely lobed leaves, white flowers, turning purple (but rarely with purple at the base of the petals) deeply cleft bracts, and ovate four- to five-celled bolls from which the lint is free at maturity. Tournefourt, in 1700, described it as the 'finest American cotton with greenish seeds'; Linnæus, in 1763, called it *Gossypium hirsutum,* and this is the name by which it should now be known.

The Influence of Insoluble Substances on the Poisonous Action of Aqueous Solutions on Plants: DR. RODNEY H. TRUE.

The paper by Dr. True, on the effect exerted on the action of poisonous substances by the presence of insoluble bodies in the solutions, presented in a preliminary way the results of a series of experiments, still in progress.

Finely divided paraffine, quartz sand, filter paper, and other insoluble substances were found to reduce the action of salts of the heavy metals and of certain non-electrolytes by their mere presence. This was explained on the basis of a supposed adsorption of the molecules of the poisonous compound by the surface of the insoluble body. A parallel was pointed out between the rates of growth seen in solutions containing a constant amount of copper sulphate provided with increasing quantity of quartz sand, and the growth rates seen in a series of progressively diluted copper sulphate solutions. The effect was similar in both cases, indicating that the insoluble substance in its essential effect removes molecules or ions of the poisonous materials from the free solution. The bearing of this situation on all physiological problems dealing with the soil was pointed out and the

possibility of an important action in the internal physiology of plants was suggested.

The Present Confusion Among the Species of Dioscorea: Mr. W. E. Safford.

Mr. Safford became interested in the classification of the species of *Dioscorea* during his cruises among the islands of the Pacific. On many of them yams are among the principal food staples of the natives, and occur both spontaneously and in cultivation. Many distinct forms occur which have received vernacular names on the various islands, but the delimitation of species and varieties is very difficult. The same species varies under different conditions of light and moisture; leaves vary in shape, pubescence, and relative position on young and old specimens, and, indeed, on different parts of the same plant. Many of the early collectors contented themselves with giving lists of native names together with a brief description of the tubers to which they apply. Many of these names prove to be descriptive, as 'white yam,' 'blue yam,' 'one-head yam,' 'devil yam' and the like. No attempt has been made to bring together the various forms of different island groups for comparison, and no confidence can be placed in existing synonymy.

On the island of Guam the natives have divided the yams into two classes according to the shape of their leaves, calling all those with broadly cordate or orbicular leaves with a deep basal sinus 'Nika,' and those of which the leaves are more or less sagittate or hastate 'Dago.' Gaudichaud, botanist of the Freycinet expedition which visited Guam in 1818, referred the varieties called *Dago* to *Dioscorea alata,* and those called *Nika* to *Dioscorea aculeata.* In Guam the wild Nika ('Nika cimarron,' or 'Gado') differs radically from the cultivated form in having a mass of lateral roots about the base modified into sharp, wiry, branching spines. Whatever may have been the cause of their origin, they serve to protect the sweet farinaceous tuber below. Gaudichaud referred this species to *D. aculeata,* but it proves to be *D. spinosa* Roxb.

Linnæus' descriptions are brief and quite insufficient. Many of them were evidently made from type plants in poor condition, and in some of them a single description included two or more species. According to Sir Joseph Hooker a part of Linnæus' description of *Dioscorea sativa* ('Spec. Pl.,' ed. I., 1033) applies to *D. spinosa* Roxb., to which should also be referred Roxburgh's own *D. aculeata.* The true *D. aculeata* L. is without the basal spines above described, and *D. sativa* L. is a glabrous plant with a terete bulbiferous stem. To the latter species should be referred the *D. bulbosa* of Robert Brown.

In looking over herbarium specimens it becomes apparent that yams can not be studied from dried plants. Points of distinction often lie in the flowers or fruit, which are often wanting in herbaria or are represented by only one sex. Cultivated yams are propagated asexually; and many varieties, like those of sweet potatoes, ginger, *Colocasia,* and other cultivated plants, are seldom seen in flower or fruit. Other species have been differentiated according to the form of their tubers; and these are almost always lacking in herbaria. Still others have been described with reasonable accuracy, but figures of different species have been cited as illustrations.

Sir Joseph Hooker found the species of Indian Dioscoreæ in such indescribable confusion that, after devoting much labor in determining and delimiting them, he had to let them appear in his 'Flora of British India' in a shape most unsatisfactory to himself, saying that he could not hope to avoid errors; that the Roxburghian food-yielding species are for the most part indeterminable, and that the Malayan species are even more loosely described than the Indian; while in the Wallichian collection, which is very complete, the species are often mixed.

It is evident then that food-yielding varieties of *Dioscorea* must be studied on the spot where they are cultivated, and not in market places or in museums. Series of complete specimens of the plants should be secured, showing different parts of the stem, basal and cauline leaves, flowers of both sexes, fruit and photographs of growing plants and tubers attached to the stem, together with specimens in alcohol or formalin of the inflorescence and the tubers themselves.

In this way alone will it be possible to bring together and compare in a satisfactory manner forms from Polynesia, India, the Malay Archipelago, Africa, Australia and America.

HERBERT J. WEBBER,
Corresponding Secretary.

FACULTY SCIENCE CLUB OF WELLESLEY COLLEGE.

THE meetings of the Faculty Science Club for the current academic year have been of sustained interest. Professor Charlotte F. Roberts spoke in October on the 'Action of Metallic Magnesium upon Aqueous Solutions,' detailing experiments performed in the chemical laboratory, the results of which were published in the *Journal of the Chemical Society.*

The November meeting was addressed by Professor Sarah F. Whiting, on 'The Latest Theory of Electricity and its Historical Development.' This paper was amply illustrated by experiment, and finally some radium salt was exhibited, also photographs taken with it, and its action in discharging electricity.

Professor Irving Fisher, of Yale, was the guest of the club in December, and spoke on 'Sundials, their Different Forms and Mathematical Theory.' He especially described a bronze cylindrical sundial of his own construction, which gives not only local apparent time but that of any standard meridian and sidereal time. This dial is, through President Hazard, placed in the Whitin Observatory.

At the January meeting Miss Alice Wilson Wilcox spoke on '*Pectinatella magnifica,*' detailing her own studies of this form. This paper was illustrated by drawings, photographs and microscopes.

GRACE LANGFORD,
Secretary.

THE SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

THE December meeting of the club was held on the 22d inst., President Turneaure in the chair.

The first paper, by Professor Sandsten, on 'Conditions which affect the Production and Fertility of Pollen,' dealt with a number of interesting questions which have been subjects of research by Professor Sandsten. A week's rain at the time of blossoming of apples was shown absolutely to prevent distribution of pollen and cause an orchard to be barren.

The second paper, by Professor Whitson, on 'The Influence of Climate on Soil,' was illustrated by striking examples of plants grown in soil which had been used for ten years in the university greenhouse, as compared with similar plants which had been grown in the same soil which had been only recently removed from the field. The plants in the first case were enormously advanced, while the comparative analysis of the soils showed the greenhouse soil to be much richer in soluble matter and to have undergone marked nitrification.

THE January meeting of the club was called to order on the twenty-sixth at 7:30 P.M. in the physical lecture room of Science Hall, President Turneaure in the chair.

The first part of the evening was devoted to reports of the recent meetings of the science associations. W. H. Hobbs reported on the geology and mineralogy section of the American Association for the Advancement of Science; B. W. Snow on the physics section of the American Association for the Advancement of Science; V. Lenher on the American Chemical Society, E. B. Skinner on the Wisconsin Academy of Sciences, Arts and Letters.

The paper of the evening, 'Some Economic Problems in the Location of the K. L. and J. R. R. in Tennessee,' by W. D. Taylor, was presented in a very interesting manner, being illustrated by lantern slides of the region and of the workings in the construction of the road.

VICTOR LENHER,
Secretary.

THE NORTHEASTERN SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE forty-ninth regular meeting of the section was held at the rooms of the Tech. Union, Massachusetts Institute of Technology, Boston, Friday, January 22, at 8 P.M., with President W. H. Walker in the chair. Forty members were present.

Mr. Maximilian Toch, of New York, pre-

sented a paper on the 'Permanent Protection of Iron and Steel,' in which he discussed the different kinds of coatings used for the purpose, with especial reference to the good effects obtainable by the use of a paint made from Portland cement of a certain definite composition. Lantern slides were shown illustrating the microscopical character of cements of various compositions, and the effects of corrosion on structural iron and steel.

Arthur M. Comey,
Secretary.

DISCUSSION AND CORRESPONDENCE.

CONVOCATION WEEK.

To the Editor of Science: I, with doubtless many others, feel indebted to you for the clear exposition, in your editorial on convocation week, of certain problems in the policy of the American Association. The purposes of the association to encourage research and specialization and, at the same time, disseminate scientific and useful knowledge among the people, divides the membership of the association now, more than at any time in the past, into two more or less distinct groups—investigators and popular teachers. Under ideal conditions, taste and ability for these two occupations should be perfectly balanced in each individual, but rarely is this the case. With increasing specialization in science, we are approaching more and more nearly to industrial conditions, where production and distribution are the separate functions of the manufacturer and the merchant. These two deal with each other oftenest not directly, but through a middle man. There is, to be sure, a vast difference between knowledge and merchandise, but the similarity in development deserves attention. It must be admitted that at times in the past the two purposes of the association have gone but lamely together. To some lack of community of interest between them, which I grant ought not to have existed, the birth of some of our separate societies was due. If efficiency in each branch were the sole consideration, it would be better to have investigators and specialists in each science in a group by themselves for their serious work, but some point of contact among specialists in the different sciences and with the public at large must be found, or the whole system will fail from too much intellectual in-and-in breeding, on the one hand, if not from lack of popular sympathy and support, on the other. The convocation week meeting of the association, if wisely conducted, can doubtless bring together the meetings of a large number of affiliated societies, and thus effectually emphasize the common ground and common purpose of the sciences, which is now too often forgotten by both scientific societies and scientific men. The function of the association at such a meeting would be largely that of a clearing house, and the second purpose of the association could receive but the scantiest attention. This would be unsatisfactory to what I take to be the larger and more rapidly increasing part of the present membership of the association. I believe, therefore, some ampler provision should be made for this already too much neglected body by a second meeting at a different time of year, preferably in the summer season. It is plain, however, that the most careful judgment and balance must be shown in making up the programs of the two meetings, to meet effectually the double purpose of the association, and still make both meetings attractive, if not of compelling interest, to the whole membership. Aside from such considerations, the financial aspect of two meetings a year may prove to many a vexing one. It may be true that the association can, with its increased membership, carry the financial burden of two meetings; but how about the individual who in most cases is compelled to live on a salary inadequate to his growing obligations? If those who can attend but one meeting a year can be brought to see that their freedom and convenience are better served when they have two meetings from which to choose, the problem will be simplified.

The suggested change of policy seems to me one of such far-reaching importance that it should receive the broadest discussion from the most varied points of view before a decision is attempted.

Ernest Fox Nichols.

Columbia University,
February 2, 1904.

Just now, before the busy scientific men all over the country have allowed the memories of the recent holiday meetings of scientific societies to be covered up with the details of every-day work, is a good time to consider the object of the union of these organizations and how this may be made more effective. For the purpose of reading papers on subjects to which they are devoting their lives and their best enthusiasm, or to discuss the latest information, or to meet and compare notes with men of similar thought and labor, this, I take it, is the impelling motive that brings men together at a scientific association.

That the attendance on the recent meeting of the American Association for the Advancement of Science and affiliated societies at St. Louis was not larger was to be expected, in view of the fact that meetings of those interested in nearly all branches of scientific work have already been announced for next summer in the same city. Many can not sacrifice the time nor bear the expense of more than one visit to St. Louis, and will so time their visits to the fair next summer as to include the session of the scientific meetings. With regard to enthusiasm, and strict attention to the business that brought them together, and in the absence of that sensationalism, which moves every scientific man to shrug his shoulders, the St. Louis meeting was a great success.

The plan that has been inaugurated, of having all societies interested in a common work meet under the same auspices, at the same place, during 'convocation week,' has been carefully considered. That it is satisfactory is attested by the meetings already held under this arrangement; but it should receive the hearty support of every one and the cooperation of all scientific societies. Any subsection or class of specialists has a perfect right to hold a meeting elsewhere at the same time, but though a closer fellowship with men of the same cult may perhaps be attained, the larger benefit of association with those possessed of culture, and who are men of ideas, in other allied or, indeed, widely different subjects, is not attained. It is of as much importance that the horizon be extended as that we knit closer the bonds of fellowship in a limited circle. An annual meeting of affiliated societies brings about just the desired result.

It may be assumed that a large per cent. of those attending the meetings are associated with different educational institutions, and for them a winter meeting will no doubt prove most convenient, when local conditions, such as meetings of state educational and scientific bodies, are adjusted to this condition of affairs. It has been found that a general meeting held during the summer, even if as late as the last week in August, breaks in upon a vacation at the seashore, in the mountains, by the lakes, or seriously interrupts some laboratory investigation or scientific excursion. On the latter account many biologists especially have frequently been unable to attend the meetings.

There can certainly be no valid objection to having semi-annual meetings of sections or of affiliated societies held during the summer at appropriate and convenient localities, but this should not be allowed to interfere with attendance at the larger and more important *annual* meeting, held in the winter at some central and convenient point.

It will, I think, be found that the men of the central west can be depended upon to attend meetings held during convocation week, if they are not obliged to travel over from 500 to 800 miles. Some will double these distances for the sake of the advantages that a meeting of this kind affords. If the men along the Atlantic coast will do as well there will be no lack of attendance. By concerted action and hearty cooperation, then, it is possible to make the annual meeting of scientific societies, even more than it has been for the last fifty years, a center of scientific life and enthusiasm.

E. H. S. Bailey.

University of Kansas.

As is well known, the American Association for the Advancement of Science used to meet in midsummer and the different professional societies in midwinter. Now the American Association for the Advancement of Science has changed its meetings to winter and the

professional societies, many of them at least, do not feel like giving up their winter meeting. The result has been considerable friction between some of the section meetings and the other societies. The difficulties have not been removed entirely, but are being adjusted by compromises.

It occurs to me that the trouble might be removed in large measure by having meetings of the sections of the American Association for the Advancement of Science in mid-summer. They need not all meet at the same place. In fact it would be better for them not to meet at the same place, as the summer meetings should have for their paramount objects excursions and field trips, and the locality that would be highly interesting to the geologist might have little to attract a chemist or botanist.

Furthermore, the sections by meeting separately could go to smaller places which could not entertain the entire association, and thus whatever good influence these meetings might possess would be more widely distributed. The meetings in the smaller cities would probably have a greater influence than in the large cities, because in the smaller place they would be 'events' that would attract the attention and interest of nearly every one, while in large cities they attract little attention, being lost in the bustle of the city.

This arrangement would enable a greater number of the scientists to partake of the benefits of the meetings, as many could attend the summer meetings in one place who could not attend the winter meeting in another and *vice versa*.

Let us then have the meetings of the sections in the summer in a locality containing points of interest to the section concerned. For instance, Syracuse, with its many objects of geological interest, would make an admirable place of meeting for the geological section. Another summer it could go to the iron district of Lake Superior or Alabama, again to the cave district of Kentucky or Indiana, and so on from year to year.

T. C. Hopkins.

Syracuse University,
January 14, 1904.

To the Editor of Science: Referring to the questions noted in your editorial in a recent number of Science, I beg leave to suggest:

It is more and more apparent that the naturalists of the country are laboring under certain serious disadvantages by reason of which we are likely, unless we are cautious, soon to lose the whole inspiration which should come from organization. In the first place, this is an exceedingly wide country and we are, by the nature of the case, much scattered, unable to meet together in one place without a considerable sacrifice on the part of the greater number, both of time and of money. In the second place, in an effort to better this and for possibly other reasons not here to be discussed, we are at present overwhelmed with a multiplicity of organizations. The botanists, for example, are in this particular no better off than any of the rest.

For the botanists, I beg to offer the following suggestions:

Let us maintain at all hazards the botanical section of the American Association for the Advancement of Science as part of a national organization of the utmost value to the people of this country for educational reasons, if for none other. Then let us have a single Botanical Society of America to have at least two meetings per year, one of which shall always be in connection with the meeting of the American Association for the Advancement of Science. Let the program of Section G consist of two parts, the one to be offered, say, in the forenoon of each day, to be of more popular character, open to all America; the other to be in charge of the Botanical Society, to contain papers of a purely professional character, reports of research work, contributions to knowledge.

In some such way as this, it seems to me, we can preserve the high standard of our association meetings, gain the inspiration which comes from a general assembly, and at the same time not lose sight of the objects sought in the way of popular impulse, encouragement and education.

The Botanical Society might hold as many meetings as it likes, be divided into as many subdivisions as might be deemed convenient,

for purposes of local assembly and fellowship, but always with the understanding that the great meeting of the year should be with the association, which shall shift about in its sessions as heretofore.

THOMAS H. MACBRIDE.

IOWA CITY, IA.

REPLY TO AN ADDRESS: PRESENT STATUS OF SOIL INVESTIGATION.

SOME criticism of Bulletin No. 22, U. S. Department of Agriculture, has appeared recently, the tenor of which is that the authors of the bulletin have proposed new chemical methods for the determination of soil fertility, and that they have concluded that the use of fertilizers is of no value in affecting the yield of crops. These criticisms have generally been copied from Circular No. 72, Agricultural Experiment Station, University of Illinois, in which parts of sentences from Bulletin No. 22 are brought together in an attempt to show a meaning which they do not possess in their proper position. The first paragraph of an 'Explanatory Statement' prefixed to the Circular is as follows:

This address was written for the purpose of calling attention to certain discrepancies in the work of the different prominent investigators in the subject of soil fertility, especially such as have a bearing upon investigations and conclusions touching soil conditions in Illinois. The paper deals particularly with the recently issued and much advertised Bulletin No. 22, from the Bureau of Soils, United States Department of Agriculture, on 'The Chemistry of Soils as Related to Crop Production,' which says that 'practically all soils contain sufficient plant food for good crop yields,' and that 'this supply will be indefinitely maintained.' This is commonly understood and is certainly intended to mean that the use of farm manure, the growing of clover and other leguminous crops, as a source of nitrogen, or the application of bone meal or other fertilizers has little or no tendency toward permanent soil improvement, and that even the effect which they do produce is due very largely, if not entirely, to improved physical condition of the soil, which effect, the Bureau of Soils believes, can be better obtained by 'a simple rotation and change of cultural methods,' and the statement is added that 'the effect due to cultivation is also more permanent than the effect due to fertilizers.'

As a matter of fact, these statements are utterly at variance with the complete context and plain meaning of the bulletin, but they have been copied in the lay publications of this country to such an extent as to call for an explicit denial. That the authors of the bulletin fully recognize the importance of the proper use of fertilizers is made perfectly plain by the following quotations (pp. 58 and 59):

There is no question that in certain cases, and in many cases, the application of commercial fertilizers is beneficial to the crop. The experience of farmers, the enormous sums expended for commercial fertilizers, and the many experiments carried on at the experiment stations prove that under certain conditions fertilizers are very beneficial in increasing the yield of crops. The fundamental idea under all of this work, however, has been that of supplying plant food in an available form; that is, adding to the supply existing in the soil. It is significant that other conditions of growth have so much influence on the yield that in but very few instances, even after long-continued experiments, has it been demonstrated that any particular fertilizer ingredient or ingredients are required for any particular soil, and that even then the effect of the fertilizer varies so greatly from year to year that no specific law has been worked out, even for a particular soil, from which the fertilizing requirements could be deduced in any exact manner.

* * * * * * * *

In cooperative experiments carried on by Atwater, numerous cases are cited where phosphoric acid is said to be a regulating ingredient and the predominating factor in controlling crop yields one year, while it is more or less efficient in the same soil in other years, and is inefficient in many cases in the same soils in still other years. The same fact is brought out in regard to potash and nitrogen, and it is clearly and unquestionably demonstrated that the effect of fertilizers is dependent upon the season, it being so influential in one season as to be designated as a dominant factor in the yield of the crop, while on the same soil in a different season it has no apparent effect. It is not that the effect is one year greater and the next year less, which might be attributed to the previous application, but it is just as likely to be inefficient one year and the controlling factor the next year as it is to be a controlling factor one year and inefficient the succeeding year.

While it is thus explicitly stated, and it is a matter so notorious as to admit of no question, that crop yields are often affected advantageously by proper fertilizers, it is maintained that such substances can not be held as alone the chief factor in determining yield of crop, since climate, soil management, etc., produce effects of the same order of magnitude as do the fertilizers, and that it may happen that the several effects would nullify one another in any particular season, illustrations almost innumerable being on record.

Attention may also be called to the fact that the bulletin does not attempt to treat specifically of commercial fertilizers, nor of their use in practice, but the matter is brought into the text only as a necessary consequence of the discussion of the crop-producing power of soils. No claim to an exhaustive presentation of this subject was made.

It is also maintained, and the reasons therefor clearly stated, that no scheme of chemical analysis yet proposed can, in itself, determine the fertility or crop-producing power of a soil. A chemical procedure is described, novel in some respects, which the authors of the bulletin used in their researches, but it is made so evident as to allow of no misconception that this procedure has proved and would generally prove as futile as all its predecessors in attempting to show the probable productive capacity of a soil or its fertility. This is not the place to enter into a discussion of the technical reasons for the inadequacy of our analytical procedures to measure or estimate fertility, but it is safe to say that the position taken, in regard to this point at least, is in full harmony with that of the best authorities.* To cite two recent utterances on this point, at the meeting of the Association of Agricultural Colleges and Experiment Station Officers held in Washington last November (1903) Director Thorne, of the Ohio Experiment Station, in describing the results of plot experiments extending over a number of years, stated that it was difficult to see how the results could possibly have been anticipated by laboratory examinations of the soils. At this same meeting Dr. H. W. Wiley, chief of the Bureau of Chemistry, U. S. Department of Agriculture, stated: "When a man sends to me a specimen of a given soil and writes, 'Please analyze this soil and tell me what crops I can grow on it,' I send him word, 'Ask your soil itself what you can grow on it; in that way asking your question directly of the soil, you can get your answer, and in no other way.'" At a later point in this address it was explicitly stated that if chemical methods could be devised for determining the food constituents in soils, different procedures must of necessity be devised for extracting each constituent from the soil, and different procedures again for each crop.

Hopkins delivered an address at the meeting in Washington already mentioned, and has anticipated the publication of the proceedings, the address having appeared as Circular No. 72, Agricultural Experiment Station, University of Illinois. In it exceptions are taken to Bulletin No. 22, partly through evident misinterpretation of the text; partly through disapproval of the use which the authors have made of the well-known data from the Rothamsted Station, although the validity of the conclusions drawn is in general admitted; and partly because it has been possible on the basis of chemical analysis, to advise the use of fertilizers containing potassium on certain Illinois soils, with improved yield of crop. The relevancy of this last argument is not apparent unless it is meant to imply that the same method of analysis would always lead to as favorable results, a conclusion unfortunately disproved by numerous instances on record. Indeed, it is a matter worthy of notice in passing that such an instance is cited, without explanation, on page 10 of Circular No. 72 of the Illinois Experiment Station. A soil containing according to analysis an enormous amount of nitrogen (67,000 pounds per acre), an abundant amount of phosphorous (2,000 pounds per acre) but what is regarded as a deficient amount of potassium (1,200 pounds per acre) produced no corn when either

* From the many citations which could be given the following is taken as one of the most conservative: Bailey (Cornell University Agr. Exp. Sta. Bull. No. *119*, 1896) states, 'a chemical analysis of soil is only one of several means of determining the value of land, and in the general run of cases it is of secondary value.'

nitrogen or phosphorous or both were applied; yielded about the same, 36 bushels when potassium, 40 bushels when potassium and nitrogen or 38 bushels when potassium and phosphorus were applied. But when potassium, nitrogen and phosphorus were all applied, the indications of the analysis were flatly contradicted by a yield of 60 bushels.

In an 'Added Note' to the circular it is stated: "In connection with the discussion which followed the reading of this and several other addresses relating to this general subject at the convention in Washington, the fact was clearly developed that some of the new analytical methods devised by the Bureau of Soils and used in the work reported in Bulletin No. 22, instead of being 'very accurate methods of analysis,' are absolutely untrustworthy." This statement is not in accord with the facts. The only method mentioned in the discussion was that for determining phosphates. The validity of the method itself was not questioned and the discussion was confined to the discrepancy in the solubility of the phosphates in the Rothamsted soils, as shown by the results reported in the bulletin, and those reported on the same soil samples in another publication.* During the public discussion referred to it was distinctly and explicitly stated that the authors of Bulletin No. 22 were aware of the discrepancy between their results and those in the publication cited, that they believed they knew the reasons therefor through work which was being done upon the solubility of phosphates, in the laboratory of the bureau, and that they had satisfied themselves that the results given were substantially correct.

Nevertheless, in the 'Added Note' it is stated that the absolute untrustworthiness of the methods used 'is further established by an examination of the data which are given in the publications referred to,' and a table is submitted in which there is a comparison of the number of pounds of phosphorus per acre, to a depth of seven inches, in the Rothamsted soils, as calculated from the data in the two publications. In this table results are stated, 'reported' by Bureau of Soils, three minutes' extraction with distilled water, whereas the method actually employed and described in detail was to stir the soil in water vigorously for three minutes, then allow to stand twenty minutes before decanting and filtering, and the work of King was cited to show the significance of the time element. Equally inaccurate is the heading to the other column of figures which are stated as 'obtained' after fifteen hours' extraction with dilute acid. As a matter of fact, according to the statement in the paper from which the data were taken, the soils were digested for five hours in a hydrochloric acid solution, which contained enough hydrochloric acid to be a $N/200$ solution when the carbonates of the alkaline earths, etc., were neutralized, and here also the importance of the time element was emphasized by the author of the method. Beyond the inexcusable carelessness of misquoting results and statements in a controversial paper, these inaccuracies are objectionable because purposely stated in such a way as to infer invidious and quite inaccurate comparisons. Moreover, it is not at all clear why the phosphorus as determined in the two investigations should be compared on the basis of an acre surface with a depth of seven inches, for it is inconceivable that any one at this day, and in view of the well-known work of Darwin and others, would suppose that the same identical seven inches of soil would remain at the surface for any considerable period of time.

Following the table, the statement is made that the author of the *Journal* article cited "determined the phosphorus by the absolute gravimetric method of the Association of Official Agricultural Chemists, and there is no reason to doubt the accuracy of the results thus obtained. The Bureau of Soils used a newly devised colorimetric method which evidently gives results about a thousand per cent. above the truth." These statements are incorrect. The procedure of the Association of Official Agricultural Chemists was not followed; but an entirely different one, which is not absolute, but indirect; is not a gravimetric, but a volumetric one; and the accuracy of the procedure which was actually used has not been established by any published work upon it.

* *Jour. Am. Chem. Soc.*, 24, 79, 1902.

The method is described at length (*loc. cit.*, pp. 97–98) and since the author of the circular quotes freely from the paper he is presumably familiar with its contents, and his statements are inexplicable. The absurdity of the statements is also apparent from the fact that the dilute acid digestion is reported to yield one to six parts per million of P_2O_5 in the Rothamsted soils, the lower figure being obtained for four out of the seven soils, and supposing the entire solution to be used for the phosphate determination, there would be only from 0.00016 gm. to 0.00096 gm. of phosphoric acid (P_2O_5) available for weighing.

It would not be proper, and it is not permitted me, to discuss here the methods or results given in the *Journal* article as the author is a colleague in this department. It seems worth while, however, to call attention here to the work upon which the method used by the Bureau of Soils rests.

This method is the one described by Schreiner* and in the appendix of Bulletin No. 22. It appears to have been first suggested by Lepierre,† was worked out further by Jolles and Neurath,‡ Woodman and Cayvan§ and others. Its value for solutions containing dissolved silica as well as phosphates, a condition existing in aqueous extracts of soils, was critically tested in the laboratory of the Bureau of Soils by Veitch‖ and Seidell,** and at the University of Wisconsin by Schreiner.††

The results of these investigators showed the method to be of a very high order of accuracy as well as delicacy. The figures in the published papers of Veitch and Schreiner speak for themselves, and it seems entirely unnecessary to add additional ones here, although a large number of results obtained by the method on solutions of known concentrations are in our possession, and show remarkably good agreements between the results obtained and the known concentrations. The concentrations of phosphoric acid, stated as PO_4, involved in these Rothamsted soils was found to be 10.5 to 19.6 parts per million of air-dry soil or within the limits of 2 to 4.5 parts per million of solution actually examined. Veitch has given results for solutions containing from 1 to 10 parts per million and Schreiner from 1.35 to 42.8 parts per million of solution, which leave absolutely no doubt as to the validity of the method for the concentrations involved in the examination of these Rothamsted soils, or the other soils cited in the bulletin.

* *Jour. Am. Chem. Soc.*, *25*, 1056, 1903.
† *Bull. Soc. Chem.*, *15*, 1213.
‡ *Monatsh. Chem.*, *19*, 5.
§ *Jour. Am. Chem. Soc.*, *23*, 96.
‖ *Jour. Am. Chem. Soc.*, *25*, 169, 1903.
** Results unpublished.
†† *Loc. cit.*

The papers cited are all contained in readily accessible journals and they have never been disputed or controverted. It seems wiser, therefore, to confine attention to data already published than to add further figures from our own experience, which would merely accumulate evidence, all in the same direction. It is worth while to note, in this connection, that while Dr. Schreiner's investigation was done for and at the instance of the Bureau of Soils, it was actually carried on in the laboratory of the University of Wisconsin in entire ignorance of the work being done by Veitch and Seidell, and before he was acquainted with any member of the laboratory force in Washington or with the work upon which they were engaged.

The statement in the 'Added Note' 'that it has long been common chemical knowledge that water dissolves but the merest trace of phosphorus from soils' is, to say the least, misleading, and in this connection entirely unjustifiable. It must be assumed that the author is familiar with the classic paper of Dyer* in which he proposes the use of his now famous method for digesting soils in a solution of citric acid. In the early pages of this paper Dyer cites some results he obtained by digesting a soil in water. 250 grams of soil in 1,000 c.c. of water gave six parts phosphoric acid per million of dry soil. The soil and solution were in contact for two days before the examination, but no further phosphoric acid was obtained when the solution had acted on the soil for 28 days, so that it is fair to assume that the solution of the phosphoric

* *Jour. Chem. Soc.*, *65*, 115, 1894.

acid was accomplished very rapidly. By changing the ratio of water to soil from two to ten, Dyer found from seven to eighteen parts of phosphoric acid per million of dry soil. In Bulletin No. 22 the average for 147 analyses of a number of types of soil is 7.64 PO_4, equivalent to 5.73 P_2O_5, and for the Rothamsted soils from 10.5 to 19.6 PO_4 equivalent to 7.9 to 11.7 P_2O_5, figures entirely comparable with those obtained by Dyer. This question of the solubility of the phosphoric acid of the soil in water has been frequently discussed in the literature since the work of Knop, who used an unreliable method of analysis, and the very interesting replies of Schulze,* Heiden† and others. This early work has been described at length by Johnson‡ and is supposed to be familiar to every tyro in agricultural chemistry.

Analyst.	Parts P_2O_5 per Million of Soil.
Jarriges,	20
	trace
Grouven,	50
	15
	trace
Hoffmann,	50
	trace
	"
	"
Hellriegel,	10
	10
Küllenberg,	5
Mixter,	1
Heiden,	57
	26 subsoil
	53
	19 subsoil
Eichhorn,	31
Schulze,	6
Ulbricht,	trace
	7
	trace
	3

The preceding figures obtained by several investigators using varying proportions of water and soil, digesting for widely varying lengths of time, from a few minutes to many days, using generally gravimetric methods of recognized value, will show that the results presented in Bulletin No. 22 are in no way unusual, and that 'merest trace' is without significance until more specifically defined.

Several investigators besides Knop have reported only traces or no phosphoric acid in water extracts of soils, but generally because of the analytical difficulties in determining it rather than as statements of the actual amounts present.

The further reference in the 'Added Note' to Warrington's examination of drainage waters is irrelevant, since it has been perfectly well known since the time of Liebig that draining or leaching a soil does not remove the salts which may actually be in solution in the soil. Agricultural chemists are perfectly familiar with this fact through the classic papers of Liebig, Way and van Bemmelin, as well as others. Moreover, there are quite a large number of figures for drainage and lysimeter waters recorded in the literature which are much larger than that of Warrington, many of them being quoted by Johnson.*

Hilgard presented an address at the meeting in Washington, attacking Bulletin No. 22, and he also has anticipated publication of the proceedings.† Serious consideration can not be given to this paper, however, since the author claims a *non-sequitur* to the arguments of Bulletin 22, on general principles rather than specific instances. He devotes almost his entire effort to a personal attack on the present Chief of the Bureau of Soils, but incidentally expresses his displeasure with agricultural chemists of the country because they use the 'official method' of analyzing soils rather than the one which he proposed a number of years ago.

FRANK K. CAMERON.

WASHINGTON, D. C.

* *Landwirthsch. Versuch-Stat.*, *6*, 409, 1864.

† *Annal. der Landwirthsch.*, *45*, 189, 1865.

‡ 'How Crops Feed,' pp. 309 et seq., 1890.

* *Loc. cit.*

† This journal, Vol. XVIII., p. 755, 1903, and *Los Angeles Herald*, Sunday, December 27, 1903.

WOODCOCK SURGERY.

IN its desire to do nothing by halves, the American public is at present evincing an extraordinary fondness for 'nature books.' This would certainly be most commendable, were

there not evinced at the same time a lack of discrimination as deplorable as it is, in certain respects, inexcusable. We have, indeed, nature writers of every conceivable shade, from the ponderously accurate, scientific-because-incomprehensible, inartistic, biological specialist, through the whole gamut of good, bad and indifferent writers, to those who scruple not to take all manner of liberties with natural history facts in order to make an impression—and a fortune. And the public reads on with patient equanimity without distinguishing sound and critical observations on animal behavior from the drivel in which animals are humanized beyond all recognition.

Any endeavor to disturb such complacency will, perhaps, seem unkind, but it is clearly a duty which no serious student can shirk who has at heart the development of true animal psychology. In an admirable article published in the *Atlantic Monthly* for March, 1903, Mr. John Burroughs called attention to certain abominations in current nature books. He dwelt especially on the unwarrantable humanizing of animals which has become almost a mania with a certain class of writers. Mr. Burroughs's remarks, if anything, were too temperate, as events have shown. One would have supposed that his criticisms of Mr. William J. Long, for example, would have led that gentleman, before publishing further observations on animal behavior, to gain some idea of the value, or rather, lack of value, which serious students attach to anecdotes as evidences of rational endowment in animals. Instead of this, however, he publishes in a reputable and widely circulated journal (*The Outlook,* September 12, 1903) and republishes in book form with illustrations ('A Little Brother to the Bear, and Other Animal Studies') a series of anecdotes which for rank and impossible humanization of the animal can hardly be surpassed. Verily, *quem deus vult perdere prius dementat.*

Although a careful dissection of this whole article, entitled 'Animal Surgery,' would yield no little instruction and some amusement, it will suffice to quote only one of the author's anecdotes with a brief commentary:

"Twenty years ago, while sitting quietly by a brook at the edge of the woods in Bridgewater, Mass., a woodcock fluttered out into the open, and made his way to a spot on the bank where a light streak of clay showed clearly from where I was watching. It was the early hunting season, when gunners were abroad in the land, and my first impression was that this was a wounded bird that had made a long flight after being shot at, and that had now come out to the stream to drink or to bathe his wound, as birds often do. Whether this were so or not is a matter of guesswork; but the bird was acting strangely in broad daylight, and I crept nearer, till I could see him plainly on the other side of the little stream, though he was still too far away for me to be absolutely sure of what all his motions meant.

"At first he took soft clay in his bill from the edge of the water and seemed to be smearing it on one leg near the knee. Then he fluttered away on one foot for a distance and seemed to be pulling tiny roots and fibers of grass, which he worked into the clay that he had already smeared on his leg. Again he took more clay and plastered it over the fibers, putting on more and more till I could plainly see the enlargement; he worked away with strange, silent intentness for fully fifteen minutes, while I watched and wondered, scarce believing my eyes. Then he stood perfectly still for a full hour under an overhanging sod, where the eye could with difficulty find him, his only motion meanwhile being an occasional rubbing and smoothing of the clay bandage with his bill, until it hardened enough to suit him, whereupon he fluttered away from the brook and disappeared in the thick woods.

"I had my own explanation of the incredible action—namely, that the woodcock had a broken leg, and had deliberately put it into a clay cast to hold the broken bones in place until they should knit together again; but, naturally, I kept my own counsel, knowing that no one would believe in the theory. For years I questioned gunners closely, and found two who said that they had killed woodcock whose legs had at one time been broken and had healed again. As far as they could remember, the leg had in each case healed perfectly straight instead of twisting to one side,

as a chicken's leg does when broken and allowed to knit of itself. I examined hundreds of woodcock in the markets in different localities, and found one whose leg had at one time been broken by a shot and then had healed perfectly. There were plain signs of dried mud at the break; but that was also true of the other leg near the foot, which only indicated that the bird had been feeding in soft places.

"All this proved nothing to an outsider, and I kept silence as to what I had seen until last winter, twenty years afterwards, when the confirmation came unexpectedly. I had been speaking of animals before the Contemporary Club of Bridgeport, when a gentleman, a lawyer well known all over the state, came to me and told me eagerly of a curious find he had made the previous autumn. He was gunning one day with a friend, when they shot a woodcock, which on being brought in by the dog was found to have a lump of hard clay on one of its legs. Curious to know what it meant, he chipped the clay off with his penknife and found a broken bone, which was then almost healed and as straight as ever. A few weeks later the bird, had he lived, would undoubtedly have taken off the cast himself, by first soaking it in water, and there would have been nothing to indicate anything unusual about him."

Mr. Long virtually claims that a woodcock not only has an understanding of the theory of casts as adapted to fractured limbs, but is able to apply this knowledge in practice. The bird is represented as knowing the qualities of clay and mud, their lack of cohesion unless mixed with fibrous substances, their tendency to harden on exposure to the air, and to disintegrate in water. Inasmuch as woodcocks have for generations been living and feeding in muddy places, we could, perhaps, although not without some abuse of the imagination, suppose the bird to possess this knowledge. But the mental horizon of Mr. Long's woodcock is not bounded by the qualities of mud. He is familiar with the theories of bone formation and regeneration—in a word, with osteogenesis, which, by the way, is never clearly grasped by some of our university juniors. This woodcock has never been hampered by a college training, has never been required to study sections of decalcified bone—has, in fact, never seen a bone, at least to recognize it as corresponding to a part of his own anatomical structure, and yet he divines the functions of the periosteum and the necessity for proper 'setting' of the bony tissue. This wonderful knowledge can not be the result either of experience or of instinct, for it would be as absurd to claim that the same woodcock is continually breaking his legs and has learned to profit by such accidents, as to maintain that woodcocks for innumerable generations past have all broken their legs with sufficient frequency and regularity to lead to the development of such an exalted chirurgical instinct. We are inclined to believe that while the woodcock was waiting for the cast to harden on his leg, his versatile mind was revolving the problem whether even his human observer, Mr. William J. Long, would be capable of attaining to such *a priori* knowledge of the surgery of fractures without ever having seen such a thing as a bone or a cast.

Now, what are the proofs furnished by Mr. Long? First, reminiscences of 'twenty years ago.' A recent apology by Ginn and Company for the existence of Mr. Long's works informs us that the gentleman was born in 1867. He was, therefore, a lad of sixteen when he met that surgical genius among woodcocks. Granting that he was a most unusual and precocious observer, are we to suppose that twenty years can elapse in any human life without distorting and exaggerating the impressions of adolescence? Observe the wavering, nebulous language of the anecdote. The bird was 'acting strangely,' but there was absolutely no proof that his leg was broken. That such was the case is pure 'guesswork' on Mr. Long's part. He 'could see him plainly on the other side of a little stream,' but he was too far away for him to be 'absolutely sure of what all his motions meant.' He 'seemed' to be smearing clay on his leg; he 'seemed to be pulling tiny roots,' etc. Then the language suddenly becomes positive as the unwarrantable inference crystallizes into definite form in the brain of the observer. We can not sufficiently deplore the fact that this *rara avis*

with a vengeance was permitted to disappear 'in the thick woods,' after adjusting and hardening his clay cast. Could the creature have been captured, we venture to affirm that he would have been eligible to a chair of surgery in one of our leading medical schools, and a phenomenally rapid progress of the science would have been insured.

Mr. Long does not rely entirely on the hazy reminiscences of his boyhood. A brace of reminiscing 'gunners' is introduced and another surgical genius among woodcocks, who, though deeply versed in osteogenesis, must have been singularly ignorant of such comparatively simple mechanisms as firearms or he could hardly have come to such an ignominious end as hanging in a market. This bird, unfortunately, had mud on both legs, though only one of them had been injured. It is surprising that Mr. Long supplies so obvious an explanation of the presence of mud on the sound leg. As he seems to set considerable store by this woodcock anecdote, we suggest that in future editions of his work he discard so commonplace an explanation and adopt one more in harmony with the remainder of his story. Thus he might state that the fracture occurred while the bird was sojourning in a country of unusual geological formation. He was unacquainted with the physical qualities of the mud in that particular region, so that before making the cast for his fracture he made an experimental cast for his sound leg in order to test the cohesive properties of the substance.

The heavy artillery of Mr. Long's proof is the concluding reminiscence of a lawyer 'known all over' the vast state of Connecticut. Again, from a dead bird, which in this instance he has not even seen, he not only infers what the living bird had done, but he indulges in some vaticination as to what the bird 'undoubtedly' would have done had he escaped death or, in other words, evolved from his inner consciousness as clear a knowledge of firearms and explosives as of fractures and casts. Since an ounce of prophylaxis is worth at least a pound of cure, it is rather surprising that the wise woodcocks should spend so much time making casts for their broken limbs instead of keeping out of the reach of gunners.

In last analysis the whole fanciful anecdote is seen to be built on the finding of mud on the legs of a couple of dead woodcocks. In both cases the mud had accumulated at a healed fracture, not at all an unlikely occurrence in mud-frequenting birds. In the whole passage one looks in vain for a particle of authentic proof that the woodcock possesses any chirurgical knowledge or skill whatsoever. Before publishing his article, Mr. Long should have consulted his legal acquaintance on the evidential value of boyhood reminiscences and the tales of sportsmen. He seems really to put implicit confidence in all sorts of hunting and fishing yarns, even when they fall from the lips of lawyers known all over the state of Connecticut. The careful reader of the paper can see between the lines the sly, mirthful twinkle in the eyes of some of these old gunners to whom Mr. Long seems to be continually running for confirmation and amplification of his vagaries.

The passage above quoted is a fair sample of not a little of the literature that is being recommended by teachers and publishers as collateral reading for the pupils of the 'nature study' classes of our schools. Such reading is fondly supposed to afford both instruction and entertainment. That it furnishes instruction can be flatly denied, for it lacks truth, the first requisite of instructive reading. It is bad even as fiction. Amusement it undoubtedly furnishes—more, in fact, than the authors contemplate, since it not only titillates the fancy of the boys and girls, but adds to the gayety of comparative psychologists. Those who are attacking the fads of our educational system will find plenty of work awaiting them as soon as they turn their attention to the excrescences of 'nature study.'

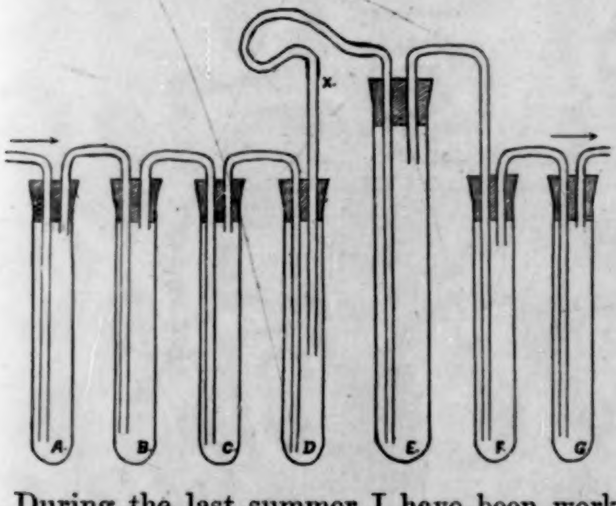
William Morton Wheeler.

SPECIAL ARTICLES.

RHYTHMS OF CO_2 PRODUCTION DURING CLEAVAGE.

The wonderful sequence of morphological changes in indirect cell division is a subject of perennial interest to biologists. The visible changes are generally recognized to be the

expressions of different physiological states. As a means of gaining further insight into the physiological conditions underlying cleavage, I adopted the plan two years ago of testing the susceptibility of the egg at different stages in the first cleavage. Potassium cyanide was used; also lack of oxygen produced by a current of hydrogen. A rhythm of alternate susceptibility and resistance was demonstrated. About ten or fifteen minutes after fertilization the echinoderm egg is very easily poisoned by KCN. The resistance increases from that time to about the time of the first cleavage. A period of susceptibility follows; then another rise of resistance as the second cleavage approaches. Probably this rhythm goes on in each subsequent division. The rhythm to lack of oxygen is similar. This makes it probable that the cell needs oxygen, especially in the period immediately following division, this being the time of nuclear growth and presumably of active synthesis.



During the last summer I have been working on the effects of heat and cold on the dividing egg. The experiments show well-marked rhythms of susceptibility and resistance during each cleavage. The details will be published later.

While pursuing this work it occurred to me that the production of CO_2 during cell division might also run in rhythms. The question seemed one of sufficient interest to warrant a careful investigation. Unfortunately apparatus for accurate chemical analysis was not available at Woods Hole. Furthermore, the season had so far advanced that only comparatively small quantities of *Arbacia* eggs were obtainable. It seems best, therefore, to put my results in the form of a preliminary publication, it being understood that the conclusions are tentative and subject to revision on further experimentation.

The apparatus finally adopted is shown in the diagram. Positive pressure forced air in the direction of the arrows. The test-tubes were tightly closed with rubber stoppers. Tubes *A* and *B* contained KOH solution to absorb the CO_2 of the air. Tube *C* contained $Ba(OH)_2$ solution and served as an indicator of the efficient action of *A* and *B*. *D* contained *Arbacia* sperm in sea water. *E* contained the unfertilized eggs of a large number of females, in sea water. These eggs had been carefully freed from body liquids and from immature ova by allowing them several times to sink through sterile, filtered sea water in test-tubes or Naples jars. Tube *E* was kept at a constant temperature, usually 23°. Tubes *F* and *G* contained $Ba(OH)_2$ solution whose degree of turbidity constituted an index of the amount of CO_2 produced by the eggs and sperm.

Before the experiment began the egg tube was nearly filled with sterile sea water and a current of air free from CO_2 passed through for several hours. Tube *D*, which meanwhile had been empty, now received a few cubic centimeters of sea water containing fresh sperm. The eggs, recently washed, were added (with as little water as possible) to the water in *E*. The air was allowed to pass for fifteen or twenty minutes. Then measured amounts of $Ba(OH)_2$ solution were placed in *F* and *G*, the air current being continued. After ten minutes the eggs were fertilized and fresh tubes substituted for *F* and *G*, the first two being securely closed with rubber stoppers and labelled '0.' Every ten minutes fresh tubes were substituted at *F* and *G*, those used during the ten minutes following fertilization being numbered '1,' and so on.

It was found that in ten minutes either before or after fertilization tube *F* became visibly turbid. On standing, a precipitate of $BaCO_3$ formed. Tube *G* showed little or no turbidity or precipitate and, therefore, was usually disregarded. In some experiments

fifteen or twenty-minute periods were used instead of ten-minute periods.

Fertilization of the eggs was accomplished in the following manner: The tube marked X was pushed down into the sperm. The latter was, therefore, immediately forced over by the air pressure and mixed with the eggs. Fertilization was usually very perfect and cleavage, so far as I could determine, went on in a normal way, provided sufficient air was forced through. In one experiment the current of air equalled 25 c.c. per minute. One difficulty experienced was the maintenance of a uniform current. This is a possible source of error.

The experiment was continued usually about two hours, or over two or three cleavages. In one case it was continued until swimming blastulæ had formed.

It will be noted that tubes '0' contained the CO_2 produced by both the sperm and unfertilized eggs during ten minutes. A single trial indicated the probability that the larger proportion of CO_2 was due to the sperm, probably because of their motility. Tubes '1,' on the other hand, contained the CO_2 produced in ten minutes by the fertilized eggs and the *unused sperm*.

It is, therefore, plain that no accurate comparisons of the CO_2 production of unfertilized and fertilized eggs, and no measurement of the CO_2 produced by the eggs in either condition, can be made until the CO_2 production of the sperm has been ascertained. This has not yet been done.

The results so far apparent may be briefly stated. It appeared in nearly all the experiments that an increase in CO_2 production occurred in the first ten- or fifteen-minute interval following fertilization. The increase was slight and sometimes could not be detected. Following this came an interval in which the CO_2 production was small, visibly less, indeed, in two or three experiments than that of the unfertilized eggs and sperm. This is the mid-period of cleavage, approximating, perhaps, the time of nuclear growth and the early stages of karyokinesis.

The interval during which the eggs were actively dividing into the first two blastomeres (say 45 to 60 minutes after fertilization) was one of active CO_2 production. In nearly every experiment the barium hydrate tubes for this time became markedly turbid as compared with any others. After this period of greater CO_2 production came an interval of lessened production. In one or two cases a second rise occurred at about the time of the second cleavage. Presumably a regular pendulum swing of increased and decreased CO_2 production occurred in the successive cleavages.

If this rhythm proves, on further investigation, to be constant, we have in the segmenting egg an interesting demonstration of the principle that oxygen consumption and CO_2 production are not parallel and concomitant processes. Pasteur's yeast experiment shows well that abundant oxygen leads to synthesis and growth, and little CO_2 is excreted. Lack of oxygen, on the other hand, means fermentation and a large production of gas. In my experiments the time of maximum oxygen need was apparently one of only moderate CO_2 production, while the period of maximum CO_2 production was really the period of least demand for oxygen. In other words, the CO_2 produced in cleavage seems to be largely the result of splitting or fermentative processes and not of direct oxidation.

Another fact clearly indicated was the increase in CO_2 production as development progresses. By the time the eggs have reached the blastula stage, even before they begin to swim, they produce much more CO_2 per hour than in earlier stages.

An effort was made to determine the CO_2 production quantitatively. At Dr. Mathew's suggestion the $BaCO_3$ in tube F was allowed to settle; measured samples of the supernatant liquid were drawn off and titrated with $m/20$ oxalic acid. Phenophthalein was used as an indicator. Enough was done to indicate the applicability of the method.

As indicated earlier in the paper, I do not consider the results so far obtained conclusive. But by the application of refined methods the problem can be solved. I hope at some future time to work out a modification of Blackman's* or Fletcher's† apparatus which may be appli-

* Blackman, *Philosophical Transactions*, Vol. 186, 1895.

† Fletcher, *Jour. of Physiol.*, Vol. 23, 1898.

cable to the conditions. It will also be necessary to command larger quantities of eggs. In this connection it may be worth mentioning that in one experiment the number of eggs used was estimated at 17,850,000. The method consisted in diluting 1 c.c. of eggs to 100 c.c. and then counting the eggs in ten drops, which equaled .4 c.c. This number seems large and several hundred animals were opened to obtain them; but from a single ripe sea urchin at the height of the season was taken a mass of eggs estimated at 4,600,000. Thus by working at the proper time of the year it will be easily possible to obtain ten times the number of eggs I was able to get for these experiments.

E. P. LYON.

UNIVERSITY OF CHICAGO.

CURRENT NOTES ON METEOROLOGY.

CLIMATOLOGY OF CALIFORNIA.

CALIFORNIA has the good fortune to have its climate discussed in considerable detail in 'Bulletin L' of the Weather Bureau (Climatology of California, by Professor A. G. McAdie). In fact this is the most complete tabulation hitherto published of the climatic data of any single state in the union. The 'Bulletin' numbers 270 pages, and is illustrated by means of numerous charts, curves and half-tone views. After a consideration of the controlling factors of the climate (pressure, storms, topography, etc.), there follow tabulated data and brief discussions of the climate of individual localities. Much of the report is naturally tabular. In some cases the tabulation is remarkably complete, as in the case of San Francisco, for example, where the daily rainfall is given for the period January 1, 1865, to March 19, 1902. Persons interested in obtaining meteorological data for California will find this report of great service. A good deal of the present 'Bulletin' has appeared in separate instalments in the *Monthly Review of the California Climate and Crop Service,* and it is a great convenience to teachers, and all others interested, to have the matter collected in one volume. Special reports on frost, fog and thunder-storms are found at the end of the 'Bulletin.'

SKY COLORS AND ATMOSPHERIC CIRCULATION.

IN *Nature* for December 24, Mr. A. L. Rotch, of Blue Hill Observatory, calls attention to the fact that the occurrence of Bishop's ring and of abnormal glows after sunset, observed at Blue Hill during the past year, was intermittent, and that the respective phenomena occurred at Blue Hill about twenty days later than they did in Switzerland. Assuming that the conclusions are approximately correct, the drift of the dust clouds from central Europe to the eastern United States was at the rate of about thirty miles an hour, or a good deal less than the velocity of the highest clouds. The importance of such studies in connection with the general circulation of the atmosphere is great, and the suggestion made by Mr. Rotch, that a committee, like the Krakatoa Committee of 1884, undertake an investigation of the recent sky colorations, will have the support of all meteorologists. In *Nature* for January 21, Mr. H. H. Clayton calls attention to the steadily diminishing size of the new Bishop's ring around the sun, as determined by measurements made at Blue Hill Observatory.

WEATHER FOLK-LORE.

UNDER the title 'Weather Folk-Lore and Local Weather Signs,' the Weather Bureau has recently published 'Bulletin No. 33' (8vo, 1903, pp. 153), prepared by Professor E. B. Garriott. The object of the 'Bulletin' is to collect the weather proverbs and sayings that are applicable to the United States, and to combine with these the local prognostics noted by observers of the Weather Bureau at the different stations over the United States. Persons who are interested in weather proverbs will find abundant material in this collection. The proverbs are grouped by subjects, as temperature, clouds, humidity, barometer, etc., often, however, rather haphazardly, as when we find under 'The physiological effects on animal life of changes of pressure' the saying 'smoke falls to the ground preceding rain.' There are several extracts from daily newspapers which, unless the writers of the articles referred to are persons of scientific standing, are out of place in an official publication of

the Weather Bureau. Over half of the 'Bulletin' is taken up with local weather signs for different Weather Bureau stations, these signs being such as the following: winds which bring precipitation; relation of pressure changes to precipitation; directions of high and of warm winds; conditions for frost, etc. In other words, these are type local weather conditions, which will doubtless prove useful to many persons. These local weather signs are illustrated by a series of seasonal charts, showing, for the United States, the directions of the rain winds; the direction of movement of cirrus or cirro-stratus clouds before rain, and the number of hours they appear before rain; the barometer heights preceding precipitation, and the wind direction during periods of high and of low temperature.

R. DEC. WARD.

HARVARD UNIVERSITY.

ELIZABETH THOMPSON SCIENCE FUND.

THE 29th meeting of the board of trustees was held at the Harvard Medical School, Boston, Mass., on February 5. The following officers were elected:

President—Henry P. Bowditch.
Treasurer—Charles S. Rackemann.
Secretary—Charles S. Minot.

The report of the treasurer, showing a balance of income on hand of $1,788.29, was read and accepted.

The secretary presented reports of progress from the holders of various grants, the work for which is not yet completed, as follows:

No. 27. E. Hartwig.	No. 98. J. Weinzirl.
60. F. Kruger.	99. H. S. Grindley.
65. O. Lubarsch.	100. H. H. Field.
71. A. Nicolas.	101. T. A. Jaggar.
73. J. von Kennell.	102. E. O. Jordan.
94. A. M. Reese.	103. E. Anding.
96. H. E. Crampton.	104. W. P. Bradley.
97. F. W. Bancroft.	106. W. Valentiner.

Professor Belopolsky having completed and published the work under grant No. 76, it was voted to close the record of that grant.

The secretary reported that 59 applications had been received for the consideration of the board, the total amount asked for being nearly $10,000. Under these circumstances it became necessary to decline, not only applications of minor interest, but also several which in the opinion of the board were of exceptional merit and highly deserving of encouragement and support.

It was voted to make the following new grants:

No. 107. $300 to Professor Morris W. Travers, London, England, for researches on the absolute scale of temperature, by experiments with liquid hydrogen.

No. 108. $150 to Professor Benjamin L. Seawell, Warrensburg, Missouri, for study of the taxonomy and ecology of the organisms of fresh-water lakes, in relation to fish foods and water supplies.

No. 109. $40 to Professor A. Nicolas, Nancy, France, for studies on the embryology of reptiles.

No. 110. $250 to Professor H. S. Grindley, Urbana, Ill., for the separation and purification of the nitrogenous substances of meats.

No. 111. $200 to Professor R. Hürthle, Breslau, Germany, to determine the relation between pressure and the obliteration of circulation.

No. 112. $143 to Professor W. J. Moenkhaus, Bloomington, Ind., for studies on the individuality of maternal and paternal chromatin in hybrids.

No. 113. $50 to S. P. Fergusson, Esq., Hyde Park, Mass., to measure the errors of absorption hygrometers.

No. 114. $300 to Dr. Werner Rosenthal, Erlangen, Germany, for researches on the Lombardy chicken pest.

No. 115. $300 to Professor Henry S. Carhart, Ann Arbor, Michigan, for the preparation and study of Clark and Weston standard cells.

CHARLES S. MINOT,
Secretary.

THE ANNUAL REPORT OF THE DIRECTOR OF THE GEOLOGICAL SURVEY.

THE twenty-fourth annual report of the director of the United States Geological Survey, which is now ready for distribution, shows that the several branches of that organization greatly enlarged the scope of their work and increased their activities during the last fiscal year. The period covered is from July 1, 1902, to July 1, 1903, for the work of which congress had appropriated the sum of $1,377,470.

The survey as now organized is divided into five branches: The geologic, topographic, hydrographic, publication and administrative.

The geologic branch includes the divisions of geology and paleontology, of mining and mineral resources and of physics and chemistry. The administration of the division of geology and paleontology was in the hands of the geologist in charge of geology, while scientific supervision rested with the chiefs of sections. The various sections included those of areal geology, Pleistocene geology, pre-Cambrian and metamorphic geology, petrology, economic geology of metalliferous ores, economic geology of non-metalliferous minerals and paleontology. A new section was created during the year—that of petrology. The petrographic laboratory maintained in connection with this section has probably no equal in the quality or the rapidity of its work.

A new feature of the work of the division of geology and paleontology was the preparation and publication of a bulletin entitled 'Contributions to Economic Geology, 1902,' which is intended to be the first of an annual series.

From the appropriation of $163,700 for geologic work allotments were made for 47 field parties, which were sent to all parts of the country. In addition to this, $14,000 was appropriated for the paleontologic work of six other parties. Brief accounts of the results accomplished by each party are given in the report.

Under authority of an act of congress making an appropriation of $60,000 for a continuation of the investigation of the mineral resources of Alaska, five parties were actively engaged in field work during the summer of 1902. A somewhat detailed account of the investigations made by these parties is given in the report.

The principal work of the division of mining and mineral resources is the preparation of the annual report on the mineral resources of the United States, although considerable time is devoted to answering technical inquiries. At the request of the director of the census, the schedules of inquiry of the twelfth census in regard to mining were included with the statistical cards annually sent out by the survey. The returns were transmitted through the Geological Survey to the Census Office, thus affording both offices the benefit of cooperation.

The division of physical and chemical research made 225 analyses of rocks and coals, and 443 qualitative determinations of minerals during the year. A research into the action of ammonium chloride on silicates was finished. Experiments were made upon methods for the analysis of cements. The experimental work of the physical laboratory related mainly to the behavior of the rock-forming minerals and analogous but somewhat simpler chemical compounds at high temperatures. Experiments upon the linear force exerted by growing crystals were also continued.

Near the close of the fiscal year, the topographic branch was reorganized for administrative purposes into two divisions, one of topography and one of geography and forestry. The division of topography now includes three sections: The eastern and western, and a third section, subordinate to the other two, which is called the triangulation and computing section. A federal appropriation of $309,200 was spent on the work, besides an additional sum of $90,000 allotted by various states for cooperative work.

The year's work of the division of topography may be summarized as follows: Two base lines were measured; primary azimuth observations were made at 4 triangulation stations; 395 triangulation stations were occupied or located; 1,487 miles of primary traverse were run; 36,275 square miles were covered by detailed topographic mapping, this area being distributed through 36 states and territories; 29,160 miles of levels were run; and 1,826 permanent bench marks were established, and at each of these an iron post, a bronze or aluminum tablet, or a copper or aluminum plug was set in place. In connection with the Alaskan surveys, about 20,080 square miles were mapped topographically. About 45 miles of the boundary of the Bighorn Forest Reserve of Wyoming were surveyed and marked with special iron posts,

this work completing the survey of the reserve; also 154 miles of the boundaries of the Black Mesa Forest Reserve and 12 miles of those of the Mount Graham Forest Reserve of Arizona were surveyed and similarly marked. In the office 97 atlas sheets were completed and the entire revision and redrafting of the large topographic wall map of the United States was commenced.

The division of geography and forestry was instrumental in making an agreement between the representatives of the farming industry and the sheep industry in Utah, to the effect that the entire mountain region of Utah, which constitutes at present the summer range for sheep, be reserved; that in such portions of these reserves as contributed to the water supply of the agricultural settlements sheep grazing be prohibited; that the remaining portions of the reserves be allotted to the various sheep owners for extended periods, and that the number of sheep to be grazed upon a unit of area be restricted far below the present number. About 7,500 square miles of forest reserves were examined during the season. The appropriation for this work amounted to $130,000.

The funds available for the work of the division of hydrography were doubled by the appropriation act of June 28, 1902, and the operations under the reclamation law were entrusted to the officials of this division. As a consequence, it became necessary, for administrative purposes, to create a separate branch of the Geological Survey. This is known as the hydrographic branch, and includes the work of the division of hydrography and also that of the reclamation service, organized to carry on the surveys and examinations authorized by the reclamation law. The proceeds of the sale of public lands in the western states and territories, which were set aside to create a fund for this purpose, amount to between $3,000,000 and $4,000,000 a year. Preliminary investigations made to show the extent to which the arid lands can be reclaimed by irrigation have been carried on by the Geological Survey for many years. At the beginning of the fiscal year the various engineers who had previously been engaged in these investigations were provided with added facilities for extending the work and carrying on to construction the projects that were considered feasible. Surveys and examinations were made in the states of Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington and Wyoming.

A division of hydrology has also been added to the hydrographic branch, the purpose of which is to study geologic conditions governing the occurrence of underground waters. Another feature of this branch is the division of hydro-economics, of which the chief raison d'être is the investigation of the equality of water and its effect on various industries.

Many interesting details are also given in this report concerning the work of the publication and administrative branches of the survey. Significant of the amount of matter published by the survey is the statement that 20,756 pages of manuscript were edited during the year and 257 atlas sheets and special maps were engraved.

This report is published for gratuitous distribution and may be procured on application to the director of the Geological Survey, Washington, D. C.

EMIL ALEXANDER DE SCHWEINITZ.

THE Medical and Dental Departments of Columbian University have passed the following resolutions in memory of the late Dr. de Schweinitz:

A great calamity has befallen the medical and dental departments of the Columbian University in the death of Dr. Emil A. de Schweinitz, professor of chemistry and toxicology and dean of the medical faculty.

Dr. de Schweinitz became professor of chemistry in 1893, and four years thereafter (1897) he was appointed dean of the medical faculty. He filled both positions with marked ability until his death on February 15, 1904.

Not only was he admired and beloved by the students for his ability as a skillful teacher, both in the lecture room and laboratory, but his gentle method and kindly interest in their welfare won for him their devout regard and unlimited esteem.

In his work as dean of the medical faculty he displayed unusual executive ability. In the equipment and internal arrangement of laboratories for the new college building he labored with untiring industry, care and skill; and in the establishment of a hospital for the medical school (for which many of us worked conjointly) it may be safely said that in the original design of this institution the leading spirit whose persistent and energetic efforts became a prime factor in the development of the enterprise, and whose never-failing hope encouraged those of us who were inclined to despond, was the progressive and unrelenting spirit of Dr. de Schweinitz.

In thus recording our appreciation of his valued services to ourselves and our university, we must not neglect also to join with the world of scientific medicine at large in commending his important labors in the domain of original research. His work in bacteriology, in the investigation of tuberculosis and other infectious diseases both in men and animals, has won for him deserved distinction and renown.

Cut off suddenly in the prime of his manhood and professional usefulness, we devoutly mourn his untimely end. In his demise we have lost a friend, counselor and companion whom we had learned to love, honor and admire.

We offer to his bereaved relatives our tenderest sympathy.

SCIENTIFIC NOTES AND NEWS.

THE American Institute of Electrical Engineers held its annual dinner in New York on February 11, at the same time celebrating the fifty-seventh birthday of Mr. Thomas A. Edison. The president of the institute, Mr. J. B. Arnold, made the opening address. Mr. Edison was unwilling to make a speech, but replied by sending a telegraphic message through an installation placed in the room. Addresses were made by Professor A. E. Kennelly, of Harvard University, Professor Cyrus F. Brackett, of Princeton University, Mr. Joseph B. McCall and Mr. C. L. Edgar. The deed of gift of the Edison Medal, for which about $7,000 had been collected, was presented to the institute by Mr. F. Insull. Many congratulatory messages were read, including the following from President Roosevelt: I congratulate you as one of the Americans to whom America owes much; as one of the men whose life work has tended to give America no small portion of its present position in the international world.

THE centenary of the death of Kant was commemorated on February 12 by the university and the town of Königsberg. A tablet was unveiled by the Prussian minister of education, Dr. Studt, who made a commemorative address. The town of Königsberg has appropriated $2,500 for the establishment of a philosophical prize. A collection of Kantiana was placed on exhibition. The British Academy has also held a celebration at which an address in honor of Kant was made by Dr. Shadworth Hodgson. At Columbia University Dr. Felix Adler gave a commemorative address.

A COMMITTEE has been formed to prepare a medal in honor of the late Professor A. Cornu, the eminent physicist.

DR. EMIL FISCHER, professor of chemistry at Berlin, has been made a knight of the Prussian order 'Pour le merite.'

THE Turin Academy of Sciences has divided the Ballauri prize of about $6,000 between Signor Marconi and Professor Grassi, and has awarded the Brasso prize of about $1,600 to the Duke of the Abruzzi.

THE University of Edinburgh has awarded the Cameron prize in practical therapeutics to Professor Niels R. Finsen, M.D., of Copenhagen, in recognition of his pioneer work in connection with the application of light rays to the treatment of disease.

THE board of control of the Naval Institute has awarded the annual prize for the best essay to Lieut. S. P. Fullenwider, U.S.N. The subject was 'The Fleet and its Personnel.' The prize is $200 and life membership in the institute.

MR. JAMES GAYLEY has been elected president of the American Institute of Mining Engineers.

DR. EDWARD COWLES has resigned the superintendency of the McLean Hospital, at Waverly, Mass., where much excellent work in psychiatry has been accomplished under his direction.

MR. W. C. NASH, superintendent of the Magnetic and Meteorological Department of

Greenwich Observatory, has retired in accordance with the rules of the admiralty service. He has been connected with the observatory for forty-eight years.

Professor Marston T. Bogert, of Columbia University, was injured by an explosion in his classroom on February 20, while making a demonstration to his class in chemistry. It is expected that he will be confined to the house for about two weeks.

Bertha Stoneman, D.Sc. (Cornell, 96), who has for the past six years been professor of botany at the Huguenot College, Wellington, Cape Colony, is on her way to America on leave of absence.

Margaret C. Ferguson, Ph.D. (Cornell, 1901), instructor of botany at Wellesley College, delivered a lecture before the Boston Society of Natural History, on February 3, on 'The Development of the Gametophytes, Fertilization and Related Phenomena in Pines.'

Dr. Emil Kraepelin, of the University of Heidelberg, has gone to the Dutch East Indies to study insanity among the natives.

Professor Wilhelm Uhltoff, professor of ophthalmology at Breslau, has been appointed secretary for the next meeting of the German Men of Science and Physicians.

Dr. Karl Burckhardt, formerly geologist in the Museum of La Plata, has been appointed chief geologist of the Geological Survey of Mexico.

Dean Bovey and Professor Durley, of the faculty of applied science of McGill University, are visiting engineering schools in the United States with a view to the new railway department at McGill.

According to the New York *Evening Post* the official delegates to the sixth annual conference of American Universities were as follows: Clark University, President Hall; University of Michigan, Professor Richard Hudson; Johns Hopkins University, President Remsen and Dr. Gilman; Leland Stanford, Jr., University, President Jordan and Instructor A. H. Suzzalo; University of California, President Wheeler, Professor C. M. Bakewell and Dr. Irving Stringham; University of Pennsylvania, Professors Penniman and Newbold; Cornell University, Professor Thomas F. Crane; University of Wisconsin, Professor D. C. Munro; Columbia University, President Butler, Professors Smith, Carpenter and Perry; the Catholic University of America, Dr. George M. Bolling; Harvard University, President Eliot; Princeton University, President Wilson, Professor Andrew F. West, Dean Fine and Professor Hibben; University of Chicago, President Harper, Professors Paul Shorey and A. W. Small; Yale, President Hadley, Secretary Stokes and Professor Lounsbury.

Dr. Emil Alexander de Schweinitz, director of the Biochemic Laboratory of the U. S. Department of Agriculture and dean of the Medical Department of Columbian University, well known for his contributions to bacteriology, died at Washington on February 15, in his thirty-ninth year.

James A. Skilton, a writer on social questions and a student of Herbert Spencer, died in Brooklyn on February 19, at the age of seventy-five years.

Dr. Edward John Chapman, from 1853 to 1895 professor of mineralogy in the University of Toronto, died at the beginning of February, at the age of eighty-three years.

Dr. William Francis died on January 18, at the age of eight-five years. He was a member of the printing and publishing firm of Taylor and Francis and had been for more than fifty years one of the editors of *The Philosophical Magazine*. He had translated and abstracted many papers on chemistry and physics.

M. Firmin Bocourt, formerly curator of the Paris Museum of Natural History, died on February 4, at the age of eighty-five years. His connection with the museum began in 1834, and on its behalf he made scientific journeys to Siam, Mexico and elsewhere, being known especially for his work on the reptiles. The deaths are also announced of Baron de Ujfalvy, professor at the University of Paris, known for his researches in anthropology and his travels in central Asia, and of Dr. Luigi Barbera, professor of philosophy at the University of Bologna.

SENATOR BARNES has introduced a bill in the New York legislature appropriating $5,000 to establish in the State Prison Commission's Department a laboratory for the study of criminal, pauper and defective classes. A director of the laboratory is to be appointed by the governor at a salary of $3,000.

THE second International Congress of Philosophy will be held at Geneva from the fourth to the eighth of September of the present year. The congress meets in five sections—the history of philosophy, general philosophy and psychology, applied philosophy, logic and philosophy of the sciences and history of the sciences, the last named being at the same time the third International Congress of the History of the Sciences. The subjects announced for the general sessions are 'The place of the history of philosophy in the study of philosophy,' the definition of philosophy, the individual and the group, and final causes in biology and neo-vitalism. The honorary president of the congress is M. Ernest Naville, honorary professor of philosophy at the University of Geneva, and the president is M. J. J. Gourd, professor at the university. The general secretary to whom communications should be addressed is Dr. Ed. Claparedède, 11 Champel, Geneva.

A CORRESPONDENT writes that 'The Order of the Eshai' is a recent scientific organization whose membership consists of those who earnestly and seriously have been and are participating in the study of the paleontology and geology of the sedimentary formations of New York state. The order's monogram is a combination of the letters N and Y, slightly inverted, which form the Russian letter *eshai*, and hence this word has been used as the name of the order. One section is composed of the 'Immortales' or those who have toiled and who now have ceased from their labors, and there are two other sections composed of living members. The keeper of the rolls is Dr. John M. Clarke, state paleontologist of New York.

THE Johns Hopkins Press announces the publication of the lectures on 'Molecular Dynamics and the Wave Theory of Light,' given by Lord Kelvin at the university in October, 1884, and based on Mr. A. S. Hathaway's stenographic report; twelve appendices on allied subjects are added by Lord Kelvin.

A MEETING of gentlemen interested in astronomy was held at Edinburgh, on January 9, to make arrangements for resuscitating the Astronomical Institution, originally founded in 1812.

THE report of the meeting of the Zoological Society of London held on January 19, 1904, contains the following announcement: "An 'Abstract of the Proceedings of the Zoological Society of London' is published by the Society at 3 Hanover Square, London, W., on the Tuesday following the date of meeting to which it refers. It will be issued, free of extra charge, to all fellows who subscribe to the publications along with the 'Proceedings'; but it may be obtained on the day of publication at the price of sixpence, or, if desired, sent post-free for the sum of six shillings per annum, payable in advance." This new publication, which has started with the year 1904, is not the same as the privately distributed reports of the meetings, which will be continued as heretofore. The 'Abstract of the Proceedings' will, we understand, be a small octavo of about eight pages, and will include abstracts of the papers read, which such authors as care to publish preliminary and more or less intelligible descriptions of their new species will be at liberty to use for that purpose. We presume that the editor will not insert in the 'Abstract' brief diagnoses of any new species of which the author has not already supplied a complete and proper description, accepted by the society for ultimate publication *in extenso*.

THE Biological Society of Washington has arranged for five Saturday afternoon illustrated lectures to be given in the United States National Museum. The program of lectures is: February 20, 'The Exploration of the Deep Sea,' C. H. Townsend; February 27, 'The Living Forest,' Gifford Pinchot; March 5, 'A Naturalist's Winter in Mexico,' E. W. Nelson; March 12, 'The Evolution of the Horse,' Henry F. Osborn; March 19, 'The

Coast Region of Alaska, its Fiords, Glaciers and Volcanoes,' C. Hart Merriam.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. J. Ogden Armour has given $250,000 to the Armour Institute of Technology for an athletic field.

Mr. John A. Creighton has given a further sum of about $250,000 to Creighton University, a Catholic institution at Omaha, Nebr.

The Liverpool city council has decided to grant £10,000 to the university during 1904, on condition that the council nominate from time to time some person to inspect the work of the institution; that the university make an annual report to the council of its work, including a statement of accounts; and that not less than £1,000 of the grant be devoted for Liverpool scholarships and for the payment and remission of fees. It is intended to make the grant an annual one.

Lord Strathcona has given $20,000 to Manitoba University to extend its scientific work.

Mrs. Winbolt has offered to the University of Cambridge £500 to found an annual prize in civil engineering in memory of her late husband, Mr. John Steddy Winbolt, M.A., Trinity College.

The new Laboratory of Hygiene in the University of Jena was dedicated on January 24.

Dartmouth Hall, the oldest building of Dartmouth College and one of much historic interest, has been destroyed by fire. The loss of $25,000 is partly covered by insurance. The trustees have already resolved to rebuild the hall in more permanent material at a cost of $250,000. West College, Colgate University, has been damaged by fire, the biological and geological departments suffering especially. Several buildings belonging to the Johns Hopkins University were destroyed in the recent fire. They were, of course, insured, but the amount of loss to the university is not at present known. It is said that property to the value of $1,300,000 belonging to the Johns Hopkins Hospital was destroyed. This was insured, but there will be a large curtailment in revenue until the property can be rebuilt.

Attorney-General Cunneen holds that the land in the Adirondacks, to which Cornell University took title for the purpose of a College of Forestry, has now become the property of the state, and is a part of the forest preserve. The attorney-general also holds that the contract between Cornell University and the Brooklyn Cooperage Company concerning the cutting of timber from this land is in violation of the constitution, and void.

A correspodent writes to the London *Times*, in view of recent developments at Oxford and Cambridge, that it is interesting to learn that the Cambridge Union Society has decided by a majority of 87 votes to 70 'that this house would regret the abolition of compulsory Greek in the previous examination.' This expression of undergraduate opinion appears the more significant when it is remembered how small a proportion of the members of the university are professedly classical students. Last year of the 400 students who passed the first parts of the various examinations for honors only 90 were classical men.

Dr. William C. Sturgis, formerly mycologist of the Connecticut Agricultural Experiment Station, has been appointed lecturer on botany at Colorado College, Colorado Springs.

Dr. H. K. Anderson, Caius College, Cambridge, has been appointed university lecturer in physiology in succession to Dr. Langley, appointed to the professorship.

Dr. Henry Kenwood has been appointed professor of hygiene at University College, London, in succession to the late Professor W. H. Corfield.

Dr. E. P. Wright has resigned the chair of botany at Trinity College, Dublin.

Signor Boccardi, late assistant in the Observatory of Catania, has been appointed professor of astronomy and director of the Observatory of the University of Turin.

Dr. Benno Erdmann, professor of philosophy at the University of Bonn, has been called to Tübingen.